PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Application of:

Tongbi Jiang

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For: UNDERFILL PROCESS

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Examiner: D. Graybill

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REPLY BRIEF

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Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Attn: Board of Patent Appeals and Interferences

Sirs:

This Reply Brief is being filed in the format required by 37 C.F.R. § 41.41 within two months of the October 2, 2007, mailing date of an Examiner's Answer in the above-referenced appeal.

(VII) ARGUMENT

(C) ANALYSIS

(i) 35 U.S.C. § 102(e)

Claims 58-61 stand rejected under 35 U.S.C. §102(e) as being anticipated by Yamada (U.S. Patent 5,959,363).

a. Claims 58-60

Claim 58 recites "[a] method for attaching a semiconductor assembly, said method comprising: providing a semiconductor device having an active surface; providing a substrate having an upper surface; applying a liquid wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate; connecting said semiconductor device to said substrate so that said active surface of said semiconductor device faces said upper surface of said substrate; and applying a flowable underfill material between the substrate and the semiconductor device, such that said flowable underfill material contacts said applied wetting agent layer."

The Yamada et al. reference does not anticipate the presently claimed invention of independent claim 58 under 35 U.S.C. § 102 because the Yamada et al. reference does not identically describe each and every element as set forth in the claim, either expressly or inherently, in as complete detail as is contained in the claim. Appellant asserts that the Yamada et al. reference does not identically describe, either expressly or inherently, the elements of the presently claimed invention of independent claim 58 calling for "applying a liquid wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate" and "applying a flowable underfill material between the substrate and the semiconductor device, such that said flowable underfill material contacts said applied wetting agent layer."

Appellant asserts that as set forth in MPEP § 2111 pending claims must be given their broadest reasonable interpretation consistent with the specification. Appellant asserts that the broadest reasonable interpretation of the claims must also be consistent with the interpretation that those skilled in the art would reach. Appellant asserts that during examination the USPTO

must give claims their broadest reasonable interpretation in light of the specification which means that the words of the claims must be given their plain meaning unless the plain meaning is inconsistent with the specification. Appellant asserts that the ordinary and customary meaning of a term may be evidenced by a variety of sources, including the words of the claims themselves, the remainder of the specification, the prosecution history, and extrinsic evidence concerning relevant scientific principles, the meaning of technical terms, and the state of the art. Appellant asserts that if extrinsic reference sources, such as dictionaries, evidence more than one definition for the term, the intrinsic record must be consulted to identify which of the different possible definitions is most consistent with applicant's use of the terms.

In contrast to the elements of the presently claimed invention of independent claim 58 the Yamada et al. reference describes the use of a polymer wax layer. Appellant asserts that the Yamada et al. wax layer is not a "liquid wetting agent layer" as recited in claim 58 and does not describe applying a wetting agent or essentially uniform liquid silane-based wetting agent layer to at least one of said surface of said semiconductor device and said surface of said substrate whatsoever. Yamada et al. in column 18, lines 48-57 states that "[a]ccording to the eighth embodiment, since a polymer film excellent in wettability to an encapsulation resin is coated in advance on either one of a semiconductor chip and a wiring circuit board, it is possible to employ a resin of high viscosity without requiring a longer period of time for accomplishing the encapsulating, i.e. realizing a high speed encapsulating. The employment of a resin having an increased viscosity through the use of a large amount of filler may be useful in enhancing the reliability of the resultant semiconductor device." Yamada et al. in column 54, lines 30-41, states that "[o]n the passivation film 223 of the semiconductor chip is formed a polymer film 208 which is excellent in wettability with the encapsulation resin, such as a hydrocarbon wax, a fatty acid type wax, a fatty amide type wax or an ester type wax. For example, an ester type was such as carnauba wax or montain wax is perfereable in view of their excellent moisture resistance. Other examples useful in this Example are a long chain carboxylic acid or a metal salt thereof, such as steric acid, palmitic acid, zinc stearate and calcium stearate; and a low molecular polyethylene wax. These polymers may be employed singly or in combination thereof. Other adhesion assistants may also be coated on the passivation film 223 (rather than the polymer wax

film 208 or polymer layer 208) . . . ." These other adhesion assistants are not used in place of either the first encapsulation resin 204 or the second encapsulation resin 205 or are not applied thereto after the resins 204 and 205 are applied to the semiconductor chip 201 and substrate 202 respectively. The polymer film 208 contacts either the semiconductor chip 201 and the first encapsulation resin 204 or the substrate 202 and the second encapsulation resin 205 but does not contact encapsulation resin 206 located between first encapsulation resin 204 on the semiconductor chip 201 or the second encapsulation resin 205 on the substrate 202. Neither the polymer film 208 or any adhesion assistant used in place of polymer film 208 contacts the flowable underfill resin 206 which contacts first encapsulation resin 204 and second encapsulation resin 205.

The Examiner equates the claim language setting forth the element of the claimed invention calling for "applying a liquid wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate" to the coupling agent in the second encapsulation resin 205 set forth in Yamada, col. 56, lines 45-59 wherein ". . . a 10μm-thick (sic) a second epoxy encapsulation resin comprising 350 parts by weight of cresol novolak type epoxy resin (ECON- 195XL; Sumitomo Kagaku Co.) containing a different content of filler from that in the first encapsulation resin, 54 parts by weight of phenol resin as a curing agent, 100 parts by weight of fused silica as a filler, 0.5 part by weight of benzylmethyl amine as a catalyst, 3 parts be weight of silane coupling agent, these components being pulverized, mixed and molten together, was coated on the surface of the wiring circuit board 202 covered in advance with a solder resist 222, thereby forming a second encapsulation resin layer 205. The coating method of this second encapsulation resin may be arbitrary selected." Yamada et al. describes that when a polymer wax layer 208 or polymer film 208, excellent in wettability to an encapsulation resin, is coated in advance on either one of a semiconductor chip 201 and a wiring circuit board 202, it is possible to employ a resin of high viscosity without requiring a longer period of time for accomplishing the encapsulating, i.e. realizing a high speed encapsulating. Then employment of a resin, such as second resin 205, having an increased viscosity through the use of a large amount of filler may be useful in enhancing the reliability of the resultant semiconductor device. The polymer 208 is applied to enhance the first encapsulation resin 204

or second encapsulation resin 205 contacting the semiconductor chip 201 and substrate 202. The first encapsulation resin 204 and second encapsulation resin 205 subsequently contact with the flowable underfill encapsulation resin 206 located between the semiconductor chip 201 and the substrate 202. The polymer film 208 is not in contact with the flowable underfill encapsulation resin 206 at any time. Nowhere in Yamada et al is there any description of using the polymer wax film 208 to be applied to the first encapsulation resin 204 and second encapsulation resin 205 after the resins 204 and 205 have been applied to the semiconductor chip 201 and substrate 202.

Nowhere in such description of a second encapsulation resin layer 205 is there any description of the element of the claimed invention of claim 58 calling for "applying a liquid wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate". Appellant asserts that there is no broadest reasonable interpretation to one of ordinary skill in the art for the element of the claimed invention calling for "applying a liquid wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate" to be described by Yamada et al. as the second encapsulation resin layer 205 comprising 350 parts by weight of cresol novolak type epoxy resin (ECON-195XL; Sumitomo Kagaku Co.) containing a different content of filler from that in the first encapsulation resin, 54 parts by weight of phenol resin as a curing agent, 100 parts by weight of fused silica as a filler, 0.5 part by weight of benzylmethyl amine as a catalyst, 3 parts be weight of silane coupling agent, these components being pulverized, mixed and molten together, coated on the surface of the wiring circuit board 202 covered in advance with a solder resist 222, thereby forming a second encapsulation resin layer 205. Appellant asserts that nowhere in the specification of Yamada et al. is there any such description of the element of the claimed invention calling for "applying a liquid wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate" or "a liquid wetting agent". Appellant asserts that there has been no showing that anyone of ordinary skill in the art would have as the broadest reasonable interpretation of such an element of the claimed invention and the language in the claim the description of the resin 205 set forth in Yamada et al. in col. 56, lines 45-59 and relied on by the Examiner in the Final Rejection. Appellant asserts that the

encapsulation resin layer 205 is not a liquid wetting agent layer as set forth in the element of the claimed invention of claim 58 calling for "applying a liquid wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate". Yamada et al. only describes the polymer wax layer 208 or polymer film 208 or other adhesion assistants which may be used in its place as having wettability for the application of first encapsulation resin 204 and second encapsulation resin 205 to the semiconductor chip 201 and the substrate 202.

Appellant assert that as set forth in the ELECTRONIC PACKAGING, MICROELECTRONICS, AND INTERCONNECTION DICTIONARY, as published by McGraw-Hill, Inc., copyright 1993 by McGraw-Hill, Inc. one of ordinary skill in the art knows and understands that a coupling agent is "a chemical material that can react with both the reinforcement and the resin matrix of a composite or laminate to promote a stronger bond at the interface. The agent may be applied to the reinforcement or added to the resin, or both." (See also Silanes.) Appellant asserts that one of ordinary skill in the art knows that silanes are "silicon-based chemical compounds used to treat inorganic materials such as glass fibers or mineral fillers, thereby improving the adhesion between these materials and organic resins. Silanes may be applied to the inorganic material, added to the organic material, or both. One important use is for adhesion-promoting coupling agents between glass fibers and organic resins in the manufacture of laminates for printed wiring boards." (See also Coupling Agent.) Appellant asserts that one of ordinary skill in the art knows that wetting is "(1) the ability to adhere to a surface immediately upon contact. (2) In soldering, the ability of molten solder to spread over a metal surface after the application of a flux and the proper amount of heat." Appellant asserts that one of ordinary skill in the art knows that wettability is "the degree to which surface wetting occurs. Contact can be made between the solder and metal to be soldered." (See also Wetting.)

Appellant asserts that one of ordinary skill in the art knows that the 3 parts of silane of the 453.5 total parts of the material of the second encapsulation resin layer 205 of Yamada et al. is present as a coupling agent so that the fused silica (mineral filler) and the resin can react to promote a stronger bond at the interface thereof when the resin is curing. Appellant asserts that

the second encapsulation resin layer 205 of Yamada et al. is not the element of the claimed invention of claim 58 calling for "applying a liquid wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate" or "a liquid wetting agent". Appellant asserts that the plain meaning of the element of the claimed invention calling for "applying a liquid wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate" or "a liquid wetting agent" is clearly distinguishes such from any reasonable broad interpretation of the second encapsulation layer 205 of Yamada et al. by of one of ordinary skill in the art.

As Yamada et al. does not identically describe, either expressly or inherently, each and every element of claim 58, Yamada et al. does not anticipate independent claim 58. Accordingly, independent claim 58 is allowable as well as the dependent claims 59 through 60 therefrom. Thus, the rejection of independent claim 58, and dependent claims 59-60 therefrom, should be reversed.

b. Claim 61

Claim 61 depends from claim 58 and is allowable at least for each of the reasons stated with respect to claim 58. The arguments with respect to claim 58 are incorporated herein. Claim 61 is further allowable as Yamada fails to describe, either expressly or inherently, that the wetting agent comprises a silane-based material. Rather, Yamada merely discloses that an encapsulating resin may be 3 parts by weight silane coupling agent. (Yamada, col. 56, lines 53-56).

(ii) 35 U.S.C. § 103(a)

To establish a *prima facie* case of obviousness the prior art reference (or references when combined) **must teach or suggest all the claim limitations**. *In re Royka*, 490 F.2d 981, 985 (CCPA 1974); *see also* MPEP § 2143.03. Additionally, there must be "a reason that would have prompted a person of ordinary skill in the relevant field to combine the [prior art] elements" in the manner claimed. *KSR Int'l Co. v. Teleflex Inc.*, 127 S. Ct. 1727, 1742, 167 L.Ed.2d 705, 75 USLW 4289, 82 U.S.P.Q.2d 1385 (2007). To establish a *prima facie* case of obviousness there must be a reasonable expectation of success. *In re Merck & Co., Inc.*, 800 F.2d 1091, 1097 (Fed. Cir. 1986). Furthermore, the reason that would have prompted the combination and the

reasonable expectation of success must be found in the prior art, common knowledge, or the nature of the problem itself, and not based on the Applicant's disclosure. *DyStar Textilfarben GmbH & Co. Deutschland KG v. C. H. Patrick Co.*, 464 F.3d 1356, 1367 (Fed. Cir. 2006); MPEP § 2144. Underlying the obvious determination is the fact that statutorily prohibited hindsight cannot be used. *KSR*, 127 S.Ct. at 1742; *DyStar*, 464 F.3d at 1367.

a. Claims 1-5, 7-12, 22, 62 and 64 stand rejected under 35 U.S.C. §103(a) as being obvious over Yamada in view of Schultz (U.S. Patent 6,350,840) and Pluddemann (U.S. Patent 4,961,967).

i. Claims 1-5 and 7-9

Yamada in view of Schultz and Pluddemann cannot establish a *prima facie* case of obviousness under 35 U.S.C. § 103 regarding the claimed invention of independent claim 1 because Yamada, Schultz and Pluddemann do not teach or suggest all the claim limitations regarding the elements of the claimed invention. The Examiner has offered no motivation, either in Yamada, Schultz or Pluddemann or within the knowledge of one skilled in the art, to modify Yamada to include the claim limitations regarding the elements of the claimed invention. Further, the Examiner has not identified any problem to be solved that would provide a reason to modify Yamada and has made no showing of a reasonable expectation of success that Yamada could be modified to include the claim limitations of the elements of the claimed invention. Indeed, the teachings of Yamada, Schultz and Pluddemann teach away from such a combination.

The Examiner contends that it would have been an obvious matter of design choice to modify Yamada to include the thermoplastic encapsulant material of Schultz and the liquid primer material for thermoplastics of Pluddemann. (Examiner's Answer, pages 9-11). Despite Yamada's teaching of the superiority of its thermosetting resin, the Examiner's Answer asserts, without any showing of support, that the thermoplastic material of Schultz is superior to the thermosetting underfill of Yamada. (Examiner's Answer, page 10; Yamada, col. 1, line 16 – col. 5, line 37). The Examiner further argues, without any showing of support, that because Yamada teaches that "other adhesion assistants" may be used with Yamada's *thermosetting* underfill, it would be obvious to also include the liquid primer for *thermoplastics* of Pluddemann. (Examiner's Answer, pages 10-11). However, the Answer is silent as to *why* one skilled in the

art would be motivated to modify Yamada to meet the claim limitations.

Additionally, it should be noted that where Yamada et al. teaches the use of other adhesion assistants (Column 54, lines 41-56), they are solely for the polymer wax film 208 or polymer film 208. Nowhere does Yamada et al. teach or suggest the use of other adhesion assistants for the second encapsulation resin 205.

The current rejection does not comply with the trilogy of recent Board decisions in which it was stated that the question of obviousness must be resolved "on the basis of underlying factual determinations including 1) the scope and content of the prior art, 2) any differences between the claimed subject matter and the prior art, and 3) the level of skill in the art." *See, e.g, Ex Parte Carolyn Ramsey Catan*, Appeal 2007-0820 at 9 (Board of Patent Appeals and Interferences, July 3, 2007); *Ex Parte Mary Smith*, Appeal 2007-1925 at 12 (Board of Patent Appeals and Interferences, June 25, 2007); *Ex Parte Marek Z. Kubin et al.*, Appeal 2007-0819 (Board of Patent Appeals and Interferences, May 31, 2007). This analysis is missing from the current rejection.

The Examiner has not determined "the scope and content of the prior art," but rather has merely broadly referenced large sections of Yamada while restating the independent claims of the presently claimed invention. (Examiner's Answer, pages 5-8). *See Ex Parte Mary Smith,* 2007-1925, page 14 (*citing In re Kahn,* 441 F.3d 977, 988, 78 USPQ2d 1329, 1336 (Fed. Cir. 2006)("[R]ejections on obviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusions of obviousness.")

The Examiner does not identify *where* Yamada teaches or suggests "applying a liquid wetting agent layer to one of said surface of said semiconductor device and said surface of said substrate" or "applying a flowable underfill material between the substrate and the semiconductor device, such that said flowable material contacts said liquid wetting agent layer" as recited in claim 1. In the rejection of claim 58 of the Examiner's Answer, the Examiner cites a section of Yamada et al. that states the components of a second epoxy encapsulation resin may be molten while being mixed together. (Yamada, col. 56, lines 45-59).

Appellant asserts that as set forth in MPEP § 2111 pending claims must be given their broadest reasonable interpretation consistent with the specification. Appellant asserts that the broadest reasonable interpretation of the claims must also be consistent with the interpretation that those skilled in the art would reach. Appellant asserts that during examination the USPTO must give claims their broadest reasonable interpretation in light of the specification which means that the words of the claims must be given their plain meaning unless the plain meaning is inconsistent with the specification. Appellant asserts that the ordinary and customary meaning of a term may be evidenced by a variety of sources, including the words of the claims themselves, the remainder of the specification, the prosecution history, and extrinsic evidence concerning relevant scientific principles, the meaning of technical terms, and the state of the art. Appellant asserts that if extrinsic reference sources, such as dictionaries, evidence more than one definition for the term, the intrinsic record must be consulted to identify which of the different possible definitions is most consistent with applicant's use of the terms.

In contrast to the elements of the presently claimed invention of independent claim 1 the Yamada et al. reference teaches or suggests the use of a polymer wax layer. Appellant asserts that the Yamada et al. wax layer is not a "liquid wetting agent layer" as recited in claim 1 and does not teach or suggest applying a wetting agent or essentially uniform liquid silane-based wetting agent layer to at least one of said surface of said semiconductor device and said surface of said substrate whatsoever. Yamada et al. in column 18, lines 48-57 states that "[a]ccording to the eighth embodiment, since a polymer film excellent in wettability to an encapsulation resin is coated in advance on either one of a semiconductor chip and a wiring circuit board, it is possible to employ a resin of high viscosity without requiring a longer period of time for accomplishing the encapsulating, i.e. realizing a high speed encapsulating. The employment of a resin having an increased viscosity through the use of a large amount of filler may be useful in enhancing the reliability of the resultant semiconductor device." Yamada et al. in column 54, lines 30-41, states that "[o]n the passivation film 223 of the semiconductor chip is formed a polymer film 208 which is excellent in wettability with the encapsulation resin, such as a hydrocarbon wax, a fatty acid type wax, a fatty amide type wax or an ester type wax. For example, an ester type was such as carnauba wax or montain wax is perfereable in view of their excellent moisture resistance.

Other examples useful in this Example are a long chain carboxylic acid or a metal salt thereof, such as steric acid, palmitic acid, zinc stearate and calcium stearate; and a low molecular polyethylene wax. These polymers may be employed singly or in combination thereof. Other adhesion assistants may also be coated on the passivation film 223 (rather than the polymer wax film 208 or polymer layer 208) . . . ." These other adhesion assistants are not used in place of either the first encapsulation resin 204 or the second encapsulation resin 205 or are not applied thereto after the resins 204 and 205 are applied to the semiconductor chip 201 and substrate 202 respectively. The polymer film 208 contacts either the semiconductor chip 201 and the first encapsulation resin 204 or the substrate 202 and the second encapsulation resin 205 but does not contact encapsulation resin 206 located between first encapsulation resin 204 on the semiconductor chip 201 or the second encapsulation resin 205 on the substrate 202. Neither the polymer film 208 nor any adhesion assistant used in place of polymer film 208 contacts the flowable underfill resin 206 which contacts first encapsulation resin 204 and second encapsulation resin 205.

If the Examiner is applying Yamada et al. in the same manner as with claim 58, the Examiner equates the claim language setting forth the element of the claimed invention calling for "applying a liquid wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate" to the coupling agent in the second encapsulation resin 205 set forth in Yamada, col. 56, lines 45-59 wherein ". . . a 10μm-thick (sic) a second epoxy encapsulation resin comprising 350 parts by weight of cresol novolak type epoxy resin (ECON-195XL; Sumitomo Kagaku Co.) containing a different content of filler from that in the first encapsulation resin, 54 parts by weight of phenol resin as a curing agent, 100 parts by weight of fused silica as a filler, 0.5 part by weight of benzylmethyl amine as a catalyst, 3 parts be weight of silane coupling agent, these components being pulverized, mixed and molten together, was coated on the surface of the wiring circuit board 202 covered in advance with a solder resist 222, thereby forming a second encapsulation resin layer 205. The coating method of this second encapsulation resin may be arbitrary selected." Yamada et al. teaches or suggests that when a polymer wax layer 208 or polymer film 208, excellent in wettability to an encapsulation resin, is coated in advance on either one of a semiconductor chip 201 and a wiring circuit board 202, it is

possible to employ a resin of high viscosity without requiring a longer period of time for accomplishing the encapsulating, i.e. realizing a high speed encapsulating. Then employment of a resin, such as second resin 205, having an increased viscosity through the use of a large amount of filler may be useful in enhancing the reliability of the resultant semiconductor device. The polymer 208 is applied to enhance the first encapsulation resin 204 or second encapsulation resin 205 contacting the semiconductor chip 201 and substrate 202. The first encapsulation resin 204 and second encapsulation resin 205 subsequently contact with the flowable underfill encapsulation resin 206 located between the semiconductor chip 201 and the substrate 202. The polymer film 208 is not in contact with the flowable underfill encapsulation resin 206 at any time. Nowhere in Yamada et al is there any teaching or suggestion of using the polymer wax film 208 to be applied to the first encapsulation resin 204 and second encapsulation resin 205 after the resins 204 and 205 have been applied to the semiconductor chip 201 and substrate 202. Nowhere in any teaching or suggestion of a second encapsulation resin layer 205 is there any teaching or suggestion of the element of the claimed invention of claim 1 calling for "applying a liquid wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate". Appellant asserts that there is no broadest reasonable interpretation to one of ordinary skill in the art for the element of the claimed invention calling for "applying a liquid wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate" to be taught or suggested by Yamada et al. as the second encapsulation resin layer 205 comprising 350 parts by weight of cresol novolak type epoxy resin (ECON- 195XL; Sumitomo Kagaku Co.) containing a different content of filler from that in the first encapsulation resin, 54 parts by weight of phenol resin as a curing agent, 100 parts by weight of fused silica as a filler, 0.5 part by weight of benzylmethyl amine as a catalyst, 3 parts be weight of silane coupling agent, these components being pulverized, mixed and molten together, coated on the surface of the wiring circuit board 202 covered in advance with a solder resist 222, thereby forming a second encapsulation resin layer 205. Appellant asserts that nowhere in Yamada et al. is there any such teaching or suggestion of the element of the claimed invention calling for "applying a liquid wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate" or "a liquid wetting agent".

Appellant asserts that there has been no showing that anyone of ordinary skill in the art would have as the broadest reasonable interpretation of such an element of the claimed invention and the language in the claim the for any teaching or suggestion regarding the resin 205 set forth in Yamada et al. in col. 56, lines 45-59 and relied on by the Examiner in the Final Rejection. Appellant asserts that the encapsulation resin layer 205 is not a liquid wetting agent layer as set forth in the element of the claimed invention of claim 1 calling for "applying a liquid wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate". Yamada et al. only teaches or suggests a polymer wax layer 208 or polymer film 208 or other adhesion assistants which may be used in its place as having wettability for the application of first encapsulation resin 204 and second encapsulation resin 205 to the semiconductor chip 201 and the substrate 202.

Appellant assert that as set forth in the ELECTRONIC PACKAGING, MICROELECTRONICS, AND INTERCONNECTION DICTIONARY, as published by McGraw-Hill, Inc., copyright 1993 by McGraw-Hill, Inc. one of ordinary skill in the art knows and understands that a coupling agent is "a chemical material that can react with both the reinforcement and the resin matrix of a composite or laminate to promote a stronger bond at the interface. The agent may be applied to the reinforcement or added to the resin, or both." (See also Silanes.) Appellant asserts that one of ordinary skill in the art knows that silanes are "silicon-based chemical compounds used to treat inorganic materials such as glass fibers or mineral fillers, thereby improving the adhesion between these materials and organic resins. Silanes may be applied to the inorganic material, added to the organic material, or both. One important use is for adhesion-promoting coupling agents between glass fibers and organic resins in the manufacture of laminates for printed wiring boards." (See also Coupling Agent.) Appellant asserts that one of ordinary skill in the art knows that wetting is "(1) the ability to adhere to a surface immediately upon contact. (2) In soldering, the ability of molten solder to spread over a metal surface after the application of a flux and the proper amount of heat." Appellant asserts that one of ordinary skill in the art knows that wettability is "the degree to which surface wetting occurs. Contact can be made between the solder and metal to be soldered." (See also Wetting.)

Appellant asserts that one of ordinary skill in the art knows that the 3 parts of silane of the 453.5 total parts of the material of the second encapsulation resin layer 205 of Yamada et al. is present as a coupling agent so that the fused silica (mineral filler) and the resin can react to promote a stronger bond at the interface thereof when the resin is curing. Appellant asserts that the second encapsulation resin layer 205 of Yamada et al. is not the element of the claimed invention of claim 1 calling for "applying a liquid wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate" or "a liquid wetting agent". Appellant asserts that the plain meaning of the element of the claimed invention calling for "applying a liquid wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate" or "a liquid wetting agent" clearly distinguishes such from any reasonable broad interpretation of the second encapsulation layer 205 of Yamada et al. by of one of ordinary skill in the art.

The Yamada reference clearly uses a thermosetting material as an underfill material because the Yamada teaches or suggests thermosetting resin. Yamada et al. does not teach or suggest the use of anything but a thermosetting resin. (Yamada, col. 56, lines, 23-61).

The Examiner has not identified any problem to be solved in Yamada that would lead one of skill in the art to modify Yamada to include the thermoplastic material of Schultz (which is not a claim limitation of claim 1) and the liquid primer for thermoplastics of Pluddemann. The inclusion of the Schultz reference in the rejection suggests that the liquid primer for thermoplastics of Pluddemann would not be compatible with the underfill of Yamada. Thus, Pluddemann and Yamada teach away from a direct combination.

The Schultz reference solely teaches or suggests the use of a thermoplastic material for an encapsulant and thus no motivation exists to substitute the Schultz encapsulant for the Yamada underfill material. Further, Yamada discloses the problems with prior art underfills and the superiority of the Yamada thermosetting resin. (Yamada, col. 1, line 16 – col. 5, line 37; Yamada col. 5, line 62- col. 10, line 13; col. 13, line 58 – col. 17, line 22). Thus, the Yamada reference teaches away from the Schultz encapsulant material. The Examiner has also failed to identify any motivation to modify the Yamada structure to include a liquid primer for thermoplastics of

Pluddemann. The Examiner's statements are merely conclusions based on a hindsight reconstruction of the claimed invention based on Appellant's own disclosure.

Further, in the Final Rejection and Examiner's Answer it is proposed that "it would have been obvious to combine this disclosure of Pluddemann with the disclosure of the combination of Yamada and Schultz because it would provide the 'other adhesion assistants' of Yamada having improved wetting to the thermoplastic underfill material of Yamada and Schultz". However, the "other adhesion assistants" in Yamada et al. refers to the polymer film 208 located between either the semiconductor chip 201 and the first encapsulation resin 204 or the polymer film 208 located between the second encapsulation reason 205 and the substrate. There is no teaching or suggestion in Yamada et al. that "other adhesion assistants" may be used for the second encapsulation resin 205. Additionally, if the Pluddemann wetting agent layer is used in place of second encapsulation resin 205 in Yamada et al., since the Pluddemann wetting agent layer is not an encapsulation resin, the teachings and suggestions of Yamada et al. regarding the Yamada et al. invention have been destroyed. Further, there is no reason for one of ordinary skill in the act to use the polymer wax layer 208 and a silicone wetting agent as a second encapsulation 205 while destroying Yamada et al. for its intended purposes. If the polymer wax layer 208 or polymer layer 208 of Yamada et al. is replaced by the Pluddemann wetting agent layer, such a layer is not in contact with the flowable underfill material which is required by claim 1.

Appellant asserts that in either event where the Pluddemann wetting agent layer is either substituted for the polmer wax layer 208 or polymer layer 208 of Yamada et al. or replaces the second encapsulation resin 205 of Yamada et al., any combination of Yamada et al. and Schultz and Pluddemann cannot establish a *prima facie* case of obviousness under 35 U.S.C. § 103 because either the claim limitations of claim 1 are not taught or suggested or the invention of Yamada et al. is destroyed for intended use.

Appellant further asserts that if it is intended to additionally use the Pluddemann wetting agent on the other side of second encapsulation layer 205 of Yamada et al. with the polymer wax layer 208 or the polymer layer 208 on the substrate 202 side, Yamada et al. does not teach or

suggest any such arrangement and it is a total hindsight reconstruction based solely upon Appellant's disclosure of the invention of claim 1 to do so.

Appellant further asserts that the Yamada et al. reference cannot teach or suggest the use of a thermoplastic underfill and no motivation exists to modify Yamada to include a thermoplastic underfill because a thermoplastic underfill would soften with an increase of temperature when the IC chip is being operated so that the thermoplastic underfill would be unable to compensate for any thermal mismatch between IC chip and the IC carrier thereby making the Yamada et al. invention inoperable due to the thermoplastic material loosing its strength as it is heated thereby allowing the IC chip to separate from the substrate as the bump electrodes 203 fail in shear due to the thermo-plastic material carrying no load. Additionally, thermoplastic materials have too high viscosity to be used as underfill materials as they are unable to effectively fill the small space between an IC chip mounted on an IC chip carrier using solder balls where the small space is 125 microns or less in height. Indeed, Yamada discloses, at length, drawbacks to underfill materials other than those thermosetting materials disclosed therein. (Yamada, col. 1, line 16- col. 5, line 35). Thus, no motivation exists to modify Yamada to include the thermoplastic encapsulant of Schultz.

Both Schultz and Pluddemann teach away from any combination with and modification of Yamada because no likelihood of success exists that a thermoplastic encapsulant would be a suitable substitute for a thermosetting underfill. The substitution of a thermoplastic resin of Schultz for a thermosetting resin of Yamada destroys the Yamada invention as it would fail since in operation, the thermoplastic resin of Schultz would allow the device to separate and the bump electrodes 203 to fail in shear due to the thermoplastic resin carrying no load. Further, Appellant asserts that the substitution of a liquid primer composition from Pluddemann for a resin of Yamada cannot be the substitution of an equivalent as they are not resin equivalents.

The Examiner states that "there is no requirement that the cited prior art contain any suggestion for any combination thereof." (Examiner's Answer, page 29). However, to make a prima facie case of obviousness, the Examiner must identify "a reason that would have prompted a person of ordinary skill in the relevant field to combine the [prior art] elements" in the manner claimed. *KSR Int'l Co.* 127 S. Ct. 1727; *Ex Parte Kubin.* Appeal 2007-0819, page 9. The

Examiner has not met this burden in the current case. The reason that would have prompted the combination and the reasonable expectation of success must be found in the prior art, common knowledge, or the nature of the problem itself, and not based on the Applicant's disclosure. *DyStar Textilfarben*, 464 F.3d at 1367. The Office Action is silent as to *why* one skilled in the art would be motivated to modify Yamada to meet the claim limitations or what commonality may be found in the Yamada, Schultz and Pluddemann references.

The sole teaching or suggestion for the use of a liquid wetting agent on one of the active surface of said semiconductor device and a portion of said upper surface of said substrate for use with an underfill material is solely the Appellant's disclosure because the cited prior art teaches away from any combination thereof, because if the prior art is combined as suggested in the rejection, the combination clearly destroys the operability of the primary reference and because the cited prior art does not contain any suggestion for any combination thereof.

Yamada et al., Schultz et al., and Pluddemann fails to teach or suggest the claim limitations of the elements of claim 1 and no motivation exists to modify Yamada to include the claim limitations regarding the claim limitations of the elements of claim 1. Therefore, Appellant asserts that any combination of the Yamada et al. reference, the Schultz et al. reference, and the Pluddemann reference cannot and does not establish a *prima facie* case of obviousness under 35 U.S.C. § 103 regarding the presently claimed inventions of presently amended independent claim 1 as well as the dependent claims therefrom. Accordingly, the rejection of independent claim 1 as well as dependent claims 2-5 and 7-9 therefrom should be reversed.

ii. Claims 10-12, 22

Yamada in view of Schultz and Pluddemann cannot establish a *prima facie* case of obviousness under 35 U.S.C. § 103 regarding the claimed invention of independent claim 10 because Yamada, Schultz and Pluddemann do not teach or suggest all the claim limitations regarding the elements of the claimed invention. The Examiner has offered no motivation, either in Yamada, Schultz or Pluddemann or within the knowledge of one skilled in the art, to modify Yamada to include the claim limitations regarding the elements of the claimed invention. Further, the Examiner has not identified any problem to be solved that would provide a reason to

modify Yamada and has made no showing of a reasonable expectation of success that Yamada could be modified to include the claim limitations of the elements of the claimed invention. Indeed, the teachings of Yamada, Schultz and Pluddemann teach away from such a combination.

The Examiner contends that it would have been an obvious matter of design choice to modify Yamada to include the thermoplastic encapsulant material of Schultz and the liquid primer material for thermoplastics of Pluddemann. (Examiner's Answer, pages 9-11). Despite Yamada's teaching of the superiority of its thermosetting resin, the Examiner's Answer asserts, without any showing of support, that the thermoplastic material of Schultz is superior to the thermosetting underfill of Yamada. (Examiner's Answer, page 10; Yamada, col. 1, line 16 – col. 5, line 37). The Examiner further argues, without any showing of support, that because Yamada teaches that "other adhesion assistants" may be used with Yamada's *thermosetting* underfill, it would be obvious to also include the liquid primer for *thermoplastics* of Pluddemann. (Examiner's Answer, pages 10-11). However, the Answer is silent as to *why* one skilled in the art would be motivated to modify Yamada to meet the claim limitations.

The current rejection does not comply with the trilogy of recent Board decisions in which it was stated that the question of obviousness must be resolved "on the basis of underlying factual determinations including 1) the scope and content of the prior art, 2) any differences between the claimed subject matter and the prior art, and 3) the level of skill in the art." *See, e.g, Ex Parte Carolyn Ramsey Catan*, Appeal 2007-0820 at 9 (Board of Patent Appeals and Interferences, July 3, 2007); *Ex Parte Mary Smith*, Appeal 2007-1925 at 12 (Board of Patent Appeals and Interferences, June 25, 2007); *Ex Parte Marek Z. Kubin et al.*, Appeal 2007-0819 (Board of Patent Appeals and Interferences, May 31, 2007). This analysis is missing from the current rejection.

The Examiner has not determined "the scope and content of the prior art," but rather has merely broadly referenced large sections of Yamada while restating the independent claims of the presently claimed invention. (Examiner's Answer, pages 5-8). *See Ex Parte Mary Smith*, 2007-1925, page 14 (*citing In re Kahn*, 441 F.3d 977, 988, 78 USPQ2d 1329, 1336 (Fed. Cir. 2006)("[R]ejections on obviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the

legal conclusions of obviousness.")

The Examiner does not specifically identify *where* Yamada teaches or suggests "applying a liquid wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate" or "applying a flowable underfill material between said semiconductor device and said substrate, such that said flowable material contacts said applied liquid wetting agent layer" as recited in claim 10.

Appellant asserts that as set forth in MPEP § 2111 pending claims must be given their broadest reasonable interpretation consistent with the specification. Appellant asserts that the broadest reasonable interpretation of the claims must also be consistent with the interpretation that those skilled in the art would reach. Appellant asserts that during examination the USPTO must give claims their broadest reasonable interpretation in light of the specification which means that the words of the claims must be given their plain meaning unless the plain meaning is inconsistent with the specification. Appellant asserts that the ordinary and customary meaning of a term may be evidenced by a variety of sources, including the words of the claims themselves, the remainder of the specification, the prosecution history, and extrinsic evidence concerning relevant scientific principles, the meaning of technical terms, and the state of the art. Appellant asserts that if extrinsic reference sources, such as dictionaries, evidence more than one definition for the term, the intrinsic record must be consulted to identify which of the different possible definitions is most consistent with applicant's use of the terms.

In contrast to the elements of the presently claimed invention of independent claim 10 the Yamada et al. reference teaches or suggests the use of a polymer wax layer. Appellant asserts that the Yamada et al. wax layer is not a "liquid wetting agent layer" as recited in claim 10 and does not describe applying a wetting agent or essentially uniform liquid silane-based wetting agent layer to at least one of said surface of said semiconductor device and said surface of said substrate whatsoever. Yamada et al. in column 18, lines 48-57 states that "[a]ccording to the eighth embodiment, since a polymer film excellent in wettability to an encapsulation resin is coated in advance on either one of a semiconductor chip and a wiring circuit board, it is possible to employ a resin of high viscosity without requiring a longer period of time for accomplishing the encapsulating, i.e. realizing a high speed encapsulating. The employment of a resin having an

increased viscosity through the use of a large amount of filler may be useful in enhancing the reliability of the resultant semiconductor device." Yamada et al. in column 54, lines 30-41, states that "[o]n the passivation film 223 of the semiconductor chip is formed a polymer film 208 which is excellent in wettability with the encapsulation resin, such as a hydrocarbon wax, a fatty acid type wax, a fatty amide type wax or an ester type wax. For example, an ester type was such as carnauba wax or montain wax is perfereable in view of their excellent moisture resistance. Other examples useful in this Example are a long chain carboxylic acid or a metal salt thereof, such as steric acid, palmitic acid, zinc stearate and calcium stearate; and a low molecular polyethylene wax. These polymers may be employed singly or in combination thereof. Other adhesion assistants may also be coated on the passivation film 223 (rather than the polymer wax film 208 or polymer layer 208) . . . ." These other adhesion assistants are not used in place of either the first encapsulation resin 204 or the second encapsulation resin 205 or are not applied thereto after the resins 204 and 205 are applied to the semiconductor chip 201 and substrate 202 respectively. The polymer film 208 contacts either the semiconductor chip 201 and the first encapsulation resin 204 or the substrate 202 and the second encapsulation resin 205 but does not contact encapsulation resin 206 located between first encapsulation resin 204 on the semiconductor chip 201 or the second encapsulation resin 205 on the substrate 202. Neither the polymer film 208 nor any adhesion assistant used in place of polymer film 208 contacts the flowable underfill resin 206 which contacts first encapsulation resin 204 and second encapsulation resin 205.

If the Examiner is applying Yamada et al. in the same manner as with claim 58, the Examiner equates the claim language setting forth the element of the claimed invention calling for "applying a liquid wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate" to the coupling agent in the second encapsulation resin 205 set forth in Yamada, col. 56, lines 45-59 wherein ". . . a 10μm-thick (sic) a second epoxy encapsulation resin comprising 350 parts by weight of cresol novolak type epoxy resin (ECON-195XL; Sumitomo Kagaku Co.) containing a different content of filler from that in the first encapsulation resin, 54 parts by weight of phenol resin as a curing agent, 100 parts by weight of fused silica as a filler, 0.5 part by weight of benzylmethyl amine as a catalyst, 3 parts be weight

of silane coupling agent, these components being pulverized, mixed and molten together, was coated on the surface of the wiring circuit board 202 covered in advance with a solder resist 222, thereby forming a second encapsulation resin layer 205. The coating method of this second encapsulation resin may be arbitrary selected." Yamada et al. teaches or suggests that when a polymer wax layer 208 or polymer film 208, excellent in wettability to an encapsulation resin, is coated in advance on either one of a semiconductor chip 201 and a wiring circuit board 202, it is possible to employ a resin of high viscosity without requiring a longer period of time for accomplishing the encapsulating, i.e. realizing a high speed encapsulating. Then employment of a resin, such as second resin 205, having an increased viscosity through the use of a large amount of filler may be useful in enhancing the reliability of the resultant semiconductor device. The polymer 208 is applied to enhance the first encapsulation resin 204 or second encapsulation resin 205 contacting the semiconductor chip 201 and substrate 202. The first encapsulation resin 204 and second encapsulation resin 205 subsequently contact with the flowable underfill encapsulation resin 206 located between the semiconductor chip 201 and the substrate 202. The polymer film 208 is not in contact with the flowable underfill encapsulation resin 206 at any time. Nowhere in Yamada et al is there any teaching or suggestion of using the polymer wax film 208 to be applied to the first encapsulation resin 204 and second encapsulation resin 205 after the resins 204 and 205 have been applied to the semiconductor chip 201 and substrate 202. Nowhere in any teaching or suggestion of a second encapsulation resin layer 205 is there any teaching or suggestion of the element of the claimed invention of claim 10 calling for "applying a liquid wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate". Appellant asserts that there is no broadest reasonable interpretation to one of ordinary skill in the art for the element of the claimed invention calling for "applying a liquid wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate" to be taught or suggested by Yamada et al. as the second encapsulation resin layer 205 comprising 350 parts by weight of cresol novolak type epoxy resin (ECON- 195XL; Sumitomo Kagaku Co.) containing a different content of filler from that in the first encapsulation resin, 54 parts by weight of phenol resin as a curing agent, 100 parts by weight of fused silica as a filler, 0.5 part by weight of benzylmethyl amine as a catalyst,

3 parts be weight of silane coupling agent, these components being pulverized, mixed and molten together, coated on the surface of the wiring circuit board 202 covered in advance with a solder resist 222, thereby forming a second encapsulation resin layer 205. Appellant asserts that nowhere in Yamada et al. is there any such teaching or suggestion of the element of the claimed invention calling for "applying a liquid wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate" or "a liquid wetting agent". Appellant asserts that there has been no showing that anyone of ordinary skill in the art would have as the broadest reasonable interpretation of such an element of the claimed invention and the language in the claim the for any teaching or suggestion regarding the resin 205 set forth in Yamada et al. in col. 56, lines 45-59 and relied on by the Examiner in the Final Rejection. Appellant asserts that the encapsulation resin layer 205 is not a liquid wetting agent layer as set forth in the element of the claimed invention of claim 10 calling for "applying a liquid wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate". Yamada et al. only teaches or suggests a polymer wax layer 208 or polymer film 208 or other adhesion assistants which may be used in its place as having wettability for the application of first encapsulation resin 204 and second encapsulation resin 205 to the semiconductor chip 201 and the substrate 202.

Appellant assert that as set forth in the ELECTRONIC PACKAGING, MICROELECTRONICS, AND INTERCONNECTION DICTIONARY, as published by McGraw-Hill, Inc., copyright 1993 by McGraw-Hill, Inc. one of ordinary skill in the art knows and understands that a coupling agent is "a chemical material that can react with both the reinforcement and the resin matrix of a composite or laminate to promote a stronger bond at the interface. The agent may be applied to the reinforcement or added to the resin, or both." (See also Silanes.) Appellant asserts that one of ordinary skill in the art knows that silanes are "silicon-based chemical compounds used to treat inorganic materials such as glass fibers or mineral fillers, thereby improving the adhesion between these materials and organic resins. Silanes may be applied to the inorganic material, added to the organic material, or both. One important use is for adhesion-promoting coupling agents between glass fibers and organic resins in the manufacture of laminates for printed wiring boards." (See also Coupling Agent.)

Appellant asserts that one of ordinary skill in the art knows that wetting is "(1) the ability to adhere to a surface immediately upon contact. (2) In soldering, the ability of molten solder to spread over a metal surface after the application of a flux and the proper amount of heat." Appellant asserts that one of ordinary skill in the art knows that wettability is "the degree to which surface wetting occurs. Contact can be made between the solder and metal to be soldered." (See also Wetting.)

Appellant asserts that one of ordinary skill in the art knows that the 3 parts of silane of the 453.5 total parts of the material of the second encapsulation resin layer 205 of Yamada et al. is present as a coupling agent so that the fused silica (mineral filler) and the resin can react to promote a stronger bond at the interface thereof when the resin is curing. Appellant asserts that the second encapsulation resin layer 205 of Yamada et al. is not the element of the claimed invention of claim 1 calling for "applying a liquid wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate" or "a liquid wetting agent". Appellant asserts that the plain meaning of the element of the claimed invention calling for "applying a liquid wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate" or "a liquid wetting agent" clearly distinguishes such from any reasonable broad interpretation of the second encapsulation layer 205 of Yamada et al. by of one of ordinary skill in the art.

The Yamada reference clearly uses a thermosetting material as an underfill material because the Yamada teaches or suggests thermosetting resin. (Yamada, col. 56, lines, 23-61). The Examiner has not identified any problem to be solved in Yamada that would lead one of skill in the art to modify Yamada to include the thermoplastic material of Schultz (which is not a claim limitation of claim 10) and the liquid primer for thermoplastics of Pluddemann. The inclusion of the Schultz reference in the rejection suggests that the liquid primer for thermoplastics of Pluddemann would not be compatible with the underfill of Yamada. Thus, Pluddemann and Yamada teach away from a direct combination.

The Schultz reference solely teaches or suggests the use of a thermoplastic material for an encapsulant and thus no motivation exists to substitute the Schultz encapsulant for the Yamada underfill material. Further, Yamada discloses the problems with prior art underfills and the

superiority of the Yamada thermosetting resin. (Yamada, col. 1, line 16 – col. 5, line 37; Yamada col. 5, line 62- col. 10, line 13; col. 13, line 58 – col. 17, line 22). Thus, the Yamada reference teaches away from the Schultz encapsulant material. The Examiner has also failed to identify any motivation to modify the Yamada structure to include a liquid primer for thermoplastics of Pluddemann. The Examiner's statements are merely conclusions based on a hindsight reconstruction of the claimed invention based on Appellant's own disclosure.

Further, in the Final Rejection and Examiner's Answer it is proposed that "it would have been obvious to combine this disclosure of Pluddemann with the disclosure of the combination of Yamada and Schultz because it would provide the 'other adhesion assistants' of Yamada having improved wetting to the thermoplastic underfill material of Yamada and Schultz". However, the "other adhesion assistants" in Yamada et al. refers to the polymer film 208 located between either the semiconductor chip 201 and the first encapsulation resin 204 or the polymer film 208 located between the second encapsulation reason 205 and the substrate. There is no teaching or suggestion in Yamada et al. that "other adhesion assistants" may be used for the second encapsulation resin 205. Additionally, if the Pluddemann wetting agent layer is used in place of second encapsulation resin 205 in Yamada et al., since the Pluddemann wetting agent layer is not an encapsulation resin, the teachings and suggestions of Yamada et al. regarding the Yamada et al. invention have been destroyed. If the polymer wax layer 208 or polymer layer 208 of Yamada et al. is replaced by the Pluddemann wetting agent layer, such a layer is not in contact with the flowable underfill material which is required by claim 1.

Appellant asserts that in either event where the Pluddemann wetting agent layer is either substituted for the polmer wax layer 208 or polymer layer 208 of Yamada et al. or replaces the second encapsulation resin 205 of Yamada et al., any combination of Yamada et al. and Schultz and Pluddemann cannot establish a *prima facie* case of obviousness under 35 U.S.C. § 103 because either the claim limitations of claim 1 are not taught or suggested or the invention of Yamada et al. is destroyed for intended use.

Appellant further asserts that if it is intended to additionally use the Pluddemann wetting agent on the other side of second encapsulation layer 205 of Yamada et al. with the polymer wax layer 208 or the polymer layer 208 on the substrate 202 side, Yamada et al. does not teach or

suggest any such arrangement and it is a total hindsight reconstruction based solely upon Appellant's disclosure of the invention of claim 1 to do so.

Yamada cannot teach or suggest the use of a thermoplastic underfill and no motivation exists to modify Yamada to include a thermoplastic underfill because a thermoplastic underfill would soften with an increase of temperature when the IC chip is being operated so that the thermoplastic underfill would be unable to compensate for any thermal mismatch between IC chip and the IC carrier thereby making the Yamada et al. invention inoperable due to the thermoplastic material loosing its strength as it is heated thereby allowing the IC chip to separate from the substrate as the bump electrodes 203 fail in shear due to the thermo-plastic material carrying no load. Additionally, thermoplastic materials have too high viscosity to be used as underfill materials as they are unable to effectively fill the small space between an IC chip mounted on an IC chip carrier using solder balls where the small space is 125 microns or less in height. Indeed, Yamada discloses, at length, drawbacks to underfill materials other than those thermosetting materials disclosed therein. (Yamada, col. 1, line 16- col. 5, line 35). Thus, no motivation exists to modify Yamada to include the thermoplastic encapsulant of Schultz.

Both Schultz and Pluddemann teach away from any combination with and modification of Yamada because no likelihood of success exists that a thermoplastic encapsulant would be a suitable substitute for a thermosetting underfill. The substitution of a thermoplastic resin of Schultz for a thermosetting resin of Yamada destroys the Yamada invention as it would fail since in operation, the thermoplastic resin of Schultz would allow the device to separate and the bump electrodes 203 to fail in shear due to the thermoplastic resin carrying no load. Further, Appellant asserts that the substitution of a liquid primer composition from Pluddemann for a resin of Yamada cannot be the substitution of an equivalent.

The Examiner states that "there is no requirement that the cited prior art contain any suggestion for any combination thereof." (Examiner's Answer, page 29). However, to make a prima facie case of obviousness, the Examiner must identify "a reason that would have prompted a person of ordinary skill in the relevant field to combine the [prior art] elements" in the manner claimed. *KSR Int'l Co.* 127 S. Ct. 1727; *Ex Parte Kubin,* Appeal 2007-0819, page 9. The Examiner has not met his burden in this case. The reason that would have prompted the

combination and the reasonable expectation of success must be found in the prior art, common knowledge, or the nature of the problem itself, and not based on the Applicant's disclosure. *DyStar Textilfarben*, 464 F.3d at 1367. The Office Action is silent as to *why* one skilled in the art would be motivated to modify Yamada to meet the claim limitations or what commonality may be found in the Yamada, Schultz and Pluddemann references.

The sole teaching or suggestion for the use of a liquid wetting agent on one of the active surface of said semiconductor device and the upper surface of said substrate for use with an underfill material is solely the Appellant's disclosure because the cited prior art teaches away from any combination thereof, because if the prior art is combined as suggested in the rejection, the combination clearly destroys the operability of the primary reference and because the cited prior art does not contain any suggestion for any combination thereof.

Yamada et al., Schultz et al., and Pluddemann fails to teach or suggest the claim limitations of the elements of claim 10 and no motivation exists to modify Yamada to include the claim limitations regarding the claim limitations of the elements of claim 10. Therefore, Appellant asserts that any combination of the Yamada et al. reference, the Schultz et al. reference, and the Pluddemann reference cannot and does not establish a *prima facie* case of obviousness under 35 U.S.C. § 103 regarding the presently claimed inventions of presently amended independent claim 10 as well as the dependent claims therefrom. Accordingly, the rejection of independent claim 10 as well as dependent claims 11, 12 and 22 therefrom should be reversed.

iii. Claims 62 and 63

Claim 62 of the presently claimed invention recites "[a] method for attaching a semiconductor assembly, said method comprising: providing a semiconductor device having an active surface, a first end, a second end, a first lateral side end and a second lateral side end; providing a substrate having an upper surface, a first side wall, a second side wall, a first lateral side wall and a second lateral side wall; applying a silane-based material layer to one of a portion of said active surface of said semiconductor device and a portion of said upper surface of said substrate; connecting said semiconductor device to said substrate so that said active surface of

said semiconductor device faces said upper surface of said substrate; and applying a flowable underfill material between said semiconductor device and said substrate, such that said flowable underfill material contacts said applied silane-based material layer."

Yamada in view of Schultz and Pluddemann cannot establish a *prima facie* case of obviousness under 35 U.S.C. § 103 regarding the claimed invention of independent claim 62 because Yamada, Schultz and Pluddemann do not teach or suggest all the claim limitations regarding the elements of the claimed invention. The Examiner has offered no motivation, either in Yamada, Schultz or Pluddemann or within the knowledge of one skilled in the art, to modify Yamada to include the claim limitations regarding the elements of the claimed invention. Further, the Examiner has not identified any problem to be solved that would provide a reason to modify Yamada and has made no showing of a reasonable expectation of success that Yamada could be modified to include the claim limitations of the elements of the claimed invention. Indeed, the teachings of Yamada, Schultz and Pluddemann teach away from such a combination.

The Examiner contends that it would have been an obvious matter of design choice to modify Yamada to include the thermoplastic encapsulant material of Schultz and the liquid primer material for thermoplastics of Pluddemann. (Examiner's Answer, pages 9-11). Despite Yamada's teaching of the superiority of its thermosetting resin, the Examiner's Answer asserts, without any showing of support, that the thermoplastic material of Schultz is superior to the thermosetting underfill of Yamada. (Examiner's Answer, page 10; Yamada, col. 1, line 16 – col. 5, line 37). The Examiner further argues, without any showing of support, that because Yamada teaches that "other adhesion assistants" may be used with Yamada's *thermosetting* underfill, it would be obvious to also include the liquid primer for *thermoplastics* of Pluddemann. (Examiner's Answer, pages 10-11). However, the Answer is silent as to *why* one skilled in the art would be motivated to modify Yamada to meet the claim limitations.

The current rejection does not comply with the trilogy of recent Board decisions in which it was stated that the question of obviousness must be resolved "on the basis of underlying factual determinations including 1) the scope and content of the prior art, 2) any differences between the claimed subject matter and the prior art, and 3) the level of skill in the art." *See, e.g. Ex Parte Carolyn Ramsey Catan*, Appeal 2007-0820 at 9 (Board of Patent Appeals and

Interferences, July 3, 2007); *Ex Parte Mary Smith*, Appeal 2007-1925 at 12 (Board of Patent Appeals and Interferences, June 25, 2007); *Ex Parte Marek Z. Kubin et al.*, Appeal 2007-0819 (Board of Patent Appeals and Interferences, May 31, 2007). This analysis is missing from the current rejection.

The Examiner has not determined "the scope and content of the prior art," but rather has merely broadly referenced large sections of Yamada while restating the independent claims of the presently claimed invention. (Examiner's Answer, pages 5-8). *See Ex Parte Mary Smith*, 2007-1925, page 14 (*citing In re Kahn*, 441 F.3d 977, 988, 78 USPQ2d 1329, 1336 (Fed. Cir. 2006)("[R]ejections on obviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusions of obviousness.")

The Examiner acknowledges that neither Yamada nor Schultz teaches or suggests "applying a silane-based material layer to one of a portion of said active surface of said semiconductor device and a portion of said upper surface of said substrate" or "applying a flowable underfill material between said semiconductor device and said substrate, such that said flowable underfill material contacts said applied silane-based material layer" as recited in claim 62. (Examiner's Answer, page 10).

Appellant asserts that as set forth in MPEP § 2111 pending claims must be given their broadest reasonable interpretation consistent with the specification. Appellant asserts that the broadest reasonable interpretation of the claims must also be consistent with the interpretation that those skilled in the art would reach. Appellant asserts that during examination the USPTO must give claims their broadest reasonable interpretation in light of the specification which means that the words of the claims must be given their plain meaning unless the plain meaning is inconsistent with the specification. Appellant asserts that the ordinary and customary meaning of a term may be evidenced by a variety of sources, including the words of the claims themselves, the remainder of the specification, the prosecution history, and extrinsic evidence concerning relevant scientific principles, the meaning of technical terms, and the state of the art. Appellant asserts that if extrinsic reference sources, such as dictionaries, evidence more than one definition

for the term, the intrinsic record must be consulted to identify which of the different possible definitions is most consistent with applicant's use of the terms.

In contrast to the elements of the presently claimed invention of independent claim 62 the Yamada et al. reference teaches or suggests the use of a polymer wax layer. Appellant asserts that the Yamada et al. wax layer is not a "silane based material layer" as recited in claim 62 and does not describe applying a wetting agent or essentially uniform silane-based material layer to at least one of said surface of said semiconductor device and said surface of said substrate whatsoever. Yamada et al. in column 18, lines 48-57 states that "[a]ccording to the eighth embodiment, since a polymer film excellent in wettability to an encapsulation resin is coated in advance on either one of a semiconductor chip and a wiring circuit board, it is possible to employ a resin of high viscosity without requiring a longer period of time for accomplishing the encapsulating, i.e. realizing a high speed encapsulating. The employment of a resin having an increased viscosity through the use of a large amount of filler may be useful in enhancing the reliability of the resultant semiconductor device." Yamada et al. in column 54, lines 30-41, states that "[o]n the passivation film 223 of the semiconductor chip is formed a polymer film 208 which is excellent in wettability with the encapsulation resin, such as a hydrocarbon wax, a fatty acid type wax, a fatty amide type wax or an ester type wax. For example, an ester type was such as carnauba wax or montain wax is perfereable in view of their excellent moisture resistance. Other examples useful in this Example are a long chain carboxylic acid or a metal salt thereof, sueh as steric acid, palmitic acid, zinc stearate and calcium stearate; and a low molecular polyethylene wax. These polymers may be employed singly or in combination thereof. Other adhesion assistants may also be coated on the passivation film 223 (rather than the polymer wax film 208 or polymer layer 208) . . . ." These other adhesion assistants are not used in place of either the first encapsulation resin 204 or the second encapsulation resin 205 or are not applied thereto after the resins 204 and 205 are applied to the semiconductor chip 201 and substrate 202 respectively. The polymer film 208 contacts either the semiconductor chip 201 and the first encapsulation resin 204 or the substrate 202 and the second encapsulation resin 205 but does not contact encapsulation resin 206 located between first encapsulation resin 204 on the semiconductor chip 201 or the second encapsulation resin 205 on the substrate 202. Neither the

polymer film 208 nor any adhesion assistant used in place of polymer film 208 contacts the flowable underfill resin 206 which contacts first encapsulation resin 204 and second encapsulation resin 205.

If the Examiner is applying Yamada et al. in the same manner as with claim 58, the Examiner equates the claim language setting forth the element of the claimed invention calling for "applying a silane-based material layer to one of said active surface of said semiconductor device and said upper surface of said substrate" to the coupling agent in the second encapsulation resin 205 set forth in Yamada, col. 56, lines 45-59 wherein ". . . a 10μm-thick (sic) a second epoxy encapsulation resin comprising 350 parts by weight of cresol novolak type epoxy resin (ECON-195XL; Sumitomo Kagaku Co.) containing a different content of filler from that in the first encapsulation resin, 54 parts by weight of phenol resin as a curing agent, 100 parts by weight of fused silica as a filler, 0.5 part by weight of benzylmethyl amine as a catalyst, 3 parts be weight of silane coupling agent, these components being pulverized, mixed and molten together, was coated on the surface of the wiring circuit board 202 covered in advance with a solder resist 222, thereby forming a second encapsulation resin layer 205. The coating method of this second encapsulation resin may be arbitrary selected." Yamada et al. teaches or suggests that when a polymer wax layer 208 or polymer film 208, excellent in wettability to an encapsulation resin, is coated in advance on either one of a semiconductor chip 201 and a wiring circuit board 202, it is possible to employ a resin of high viscosity without requiring a longer period of time for accomplishing the encapsulating, i.e. realizing a high speed encapsulating. Then employment of a resin, such as second resin 205, having an increased viscosity through the use of a large amount of filler may be useful in enhancing the reliability of the resultant semiconductor device. The polymer 208 is applied to enhance the first encapsulation resin 204 or second encapsulation resin 205 contacting the semiconductor chip 201 and substrate 202. The first encapsulation resin 204 and second encapsulation resin 205 subsequently contact with the flowable underfill encapsulation resin 206 located between the semiconductor chip 201 and the substrate 202. The polymer film 208 is not in contact with the flowable underfill encapsulation resin 206 at any time. Nowhere in Yamada et al is there any teaching or suggestion of using the polymer wax film 208 to be applied to the first encapsulation resin 204 and second encapsulation resin 205

after the resins 204 and 205 have been applied to the semiconductor chip 201 and substrate 202. Nowhere in any teaching or suggestion of a second encapsulation resin layer 205 is there any teaching or suggestion of the element of the claimed invention of claim 62 calling for "applying a silane-based material layer to one of said active surface of said semiconductor device and said upper surface of said substrate". Appellant asserts that there is no broadest reasonable interpretation to one of ordinary skill in the art for the element of the claimed invention calling for "applying a silane-based material layer to one of said active surface of said semiconductor device and said upper surface of said substrate" to be taught or suggested by Yamada et al. as the second encapsulation resin layer 205 comprising 350 parts by weight of cresol novolak type epoxy resin (ECON- 195XL; Sumitomo Kagaku Co.) containing a different content of filler from that in the first encapsulation resin, 54 parts by weight of phenol resin as a curing agent, 100 parts by weight of fused silica as a filler, 0.5 part by weight of benzylmethyl amine as a catalyst, 3 parts be weight of silane coupling agent, these components being pulverized, mixed and molten together, coated on the surface of the wiring circuit board 202 covered in advance with a solder resist 222, thereby forming a second encapsulation resin layer 205. Appellant asserts that nowhere in Yamada et al. is there any such teaching or suggestion of the element of the claimed invention calling for "applying a silane-based material layer to one of said active surface of said semiconductor device and said upper surface of said substrate". Appellant asserts that there has been no showing that anyone of ordinary skill in the art would have as the broadest reasonable interpretation of such an element of the claimed invention and the language in the claim the for any teaching or suggestion regarding the resin 205 set forth in Yamada et al. in col. 56, lines 45-59 and relied on by the Examiner in the Final Rejection. Appellant asserts that the encapsulation resin layer 205 is not a silane-based material layer as set forth in the element of the claimed invention of claim 62 calling for "applying a silane-based material layer to one of said active surface of said semiconductor device and said upper surface of said substrate". Yamada et al. only teaches or suggests a polymer wax layer 208 or polymer film 208 or other adhesion assistants which may be used in its place as having wettability for the application of first encapsulation resin 204 and second encapsulation resin 205 to the semiconductor chip 201 and the substrate 202 while second encapsulation resin 205 is not a silane-based material layer as

resin 205 only comprises 3 parts by weight of silane of a total material weight of 453.5. Appellant asserts that the second encapsulation resin 205 is an epoxy based resin as epoxy comprises 350 parts by weight of the total material weight of 453.5.

Appellant assert that as set forth in the ELECTRONIC PACKAGING, MICROELECTRONICS, AND INTERCONNECTION DICTIONARY, as published by McGraw-Hill, Inc., copyright 1993 by McGraw-Hill, Inc. one of ordinary skill in the art knows and understands that a coupling agent is "a chemical material that can react with both the reinforcement and the resin matrix of a composite or laminate to promote a stronger bond at the interface. The agent may be applied to the reinforcement or added to the resin, or both." (See also Silanes.) Appellant asserts that one of ordinary skill in the art knows that silanes are "silicon-based chemical compounds used to treat inorganic materials such as glass fibers or mineral fillers, thereby improving the adhesion between these materials and organic resins. Silanes may be applied to the inorganic material, added to the organic material, or both. One important use is for adhesion-promoting coupling agents between glass fibers and organic resins in the manufacture of laminates for printed wiring boards." (See also Coupling Agent.) Appellant asserts that one of ordinary skill in the art knows that wetting is "(1) the ability to adhere to a surface immediately upon contact. (2) In soldering, the ability of molten solder to spread over a metal surface after the application of a flux and the proper amount of heat." Appellant asserts that one of ordinary skill in the art knows that wettability is "the degree to which surface wetting occurs. Contact can be made between the solder and metal to be soldered." (See also Wetting.)

Appellant asserts that one of ordinary skill in the art knows that the 3 parts of silane of the 453.5 total parts of the material of the second encapsulation resin layer 205 of Yamada et al. is present as a coupling agent so that the fused silica (mineral filler) and the resin can react to promote a stronger bond at the interface thereof when the resin is curing. Appellant asserts that the second encapsulation resin layer 205 of Yamada et al. is not the element of the claimed invention of claim 1 calling for "applying a liquid wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate" or "a liquid wetting agent". Appellant asserts that the plain meaning of the element of the claimed invention

calling for "applying a silane-based material layer to one of said active surface of said semiconductor device and said upper surface of said substrate" clearly distinguishes such from any reasonable broad interpretation of the second encapsulation layer 205 of Yamada et al. by of one of ordinary skill in the art.

Further, in the Final Rejection and Examiner's Answer it is proposed that "it would have been obvious to combine this disclosure of Pluddemann with the disclosure of the combination of Yamada and Schultz because it would provide the 'other adhesion assistants' of Yamada having improved wetting to the thermoplastic underfill material of Yamada and Schultz". However, the "other adhesion assistants" in Yamada et al. refers to the polymer film 208 located between either the semiconductor chip 201 and the first encapsulation resin 204 or the polymer film 208 located between the second encapsulation reason 205 and the substrate. There is no teaching or suggestion in Yamada et al. that "other adhesion assistants" may be used for the second encapsulation resin 205. Additionally, if the Pluddemann wetting agent layer is used in place of second encapsulation resin 205 in Yamada et al., since the Pluddemann wetting agent layer is not an encapsulation resin, the teachings and suggestions of Yamada et al. regarding the Yamada et al. invention have been destroyed. If the polymer wax layer 208 or polymer layer 208 of Yamada et al. is replaced by the Pluddemann wetting agent layer, such a layer is not in contact with the flowable underfill material which is required by claim 62.

Appellant asserts that in either event where the Pluddemann wetting agent layer is either substituted for the polmer wax layer 208 or polymer layer 208 of Yamada et al. or replaces the second encapsulation resin 205 of Yamada et al., any combination of Yamada et al. and Schultz and Pluddemann cannot establish a *prima facie* case of obviousness under 35 U.S.C. § 103 because either the claim limitations of claim 62 are not taught or suggested or the invention of Yamada et al. is destroyed for intended use.

Appellant further asserts that if it is intended to additionally use the Pluddemann wetting agent on the other side of second encapsulation layer 205 of Yamada et al. with the polymer wax layer 208 or the polymer layer 208 on the substrate 202 side, Yamada et al. does not teach or suggest any such arrangement and it is a total hindsight reconstruction based solely upon Appellant's disclosure of the invention of claim 62 to do so.

The Yamada reference clearly uses a thermosetting material as an underfill material because the Yamada teaches or suggests thermosetting resin. (Yamada, col. 56, lines, 23-61). The Examiner has not identified any problem to be solved in Yamada that would lead one of skill in the art to modify Yamada to include the thermoplastic material of Schultz (which is not a claim limitation of claim 62) and the liquid primer for thermoplastics of Pluddemann. The inclusion of the Schultz reference in the rejection suggests that the liquid primer for thermoplastics of Pluddemann would not be compatible with the underfill of Yamada. Thus, Pluddemann and Yamada teach away from a direct combination.

The Schultz reference solely teaches or suggests the use of a thermoplastic material for an encapsulant and thus no motivation exists to substitute the Schultz encapsulant for the Yamada underfill material. Further, Yamada discloses the problems with prior art underfills and the superiority of the Yamada thermosetting resin. (Yamada, col. 1, line 16 – col. 5, line 37; Yamada col. 5, line 62- col. 10, line 13; col. 13, line 58 – col. 17, line 22). Thus, the Yamada reference teaches away from the Schultz encapsulant material. The Examiner has simply failed to identify any motivation to modify the Yamada structure to include a liquid primer for thermoplastics of Pluddemann. The Examiner's statements are merely conclusions based on a hindsight reconstruction of the claimed invention based on Appellant's own disclosure.

Yamada cannot teach or suggest the use of a thermoplastic underfill and no motivation exists to modify Yamada to include a thermoplastic underfill because a thermoplastic underfill would soften with an increase of temperature when the IC chip is being operated so that the thermoplastic underfill would be unable to compensate for any thermal mismatch between IC chip and the IC carrier thereby making the Yamada et al. invention inoperable due to the thermoplastic material loosing its strength as it is heated thereby allowing the IC chip to separate from the substrate as the bump electrodes 203 fail in shear due to the thermo-plastic material carrying no load. Additionally, thermoplastic materials have too high viscosity to be used as underfill materials as they are unable to effectively fill the small space between an IC chip mounted on an IC chip carrier using solder balls where the small space is 125 microns or less in height. Indeed, Yamada discloses, at length, drawbacks to underfill materials other than those

thermosetting materials disclosed therein. (Yamada, col. 1, line 16- col. 5, line 35). Thus, no motivation exists to modify Yamada to include the thermoplastic encapsulant of Schultz.

Both Schultz and Pluddemann teach away from any combination with and modification of Yamada because no likelihood of success exists that a thermoplastic encapsulant would be a suitable substitute for a thermosetting underfill. The substitution of a thermoplastic resin of Schultz for a thermosetting resin of Yamada destroys the Yamada invention as it would fail since in operation, the thermoplastic resin of Schultz would allow the device to separate and the bump electrodes 203 to fail in shear due to the thermoplastic resin carrying no load. Further, Appellant asserts that the substitution of a liquid primer composition from Pluddemann for a resin of Yamada cannot be the substitution of an equivalent.

The Examiner states that "there is no requirement that the cited prior art contain any suggestion for any combination thereof." (Examiner's Answer, page 29). However, to make a prima facie case of obviousness, the Examiner must identify "a reason that would have prompted a person of ordinary skill in the relevant field to combine the [prior art] elements" in the manner claimed. *KSR Int'l Co.* 127 S. Ct. 1727; *Ex Parte Kubin,* Appeal 2007-0819, page 9. The Examiner has not met his burden in this case. The reason that would have prompted the combination and the reasonable expectation of success must be found in the prior art, common knowledge, or the nature of the problem itself, and not based on the Applicant's disclosure. *DyStar Textilfarben*, 464 F.3d at 1367. The Office Action is silent as to *why* one skilled in the art would be motivated to modify Yamada to meet the claim limitations or what commonality may be found in the Yamada, Schultz and Pluddemann references.

The sole teaching or suggestion for the use of a silane-based material layer to one of a portion of said active surface of said semiconductor device and a portion of said upper surface of said substrate for use with an underfill material is solely the Appellant's disclosure because the cited prior art teaches away from any combination thereof, because if the prior art is combined as suggested in the rejection, the combination clearly destroys the operability of the primary reference and because the cited prior art does not contain any suggestion for any combination thereof.

Yamada et al., Schultz et al., and Pluddemann fails to teach or suggest the claim limitations of the elements of claim 62 and no motivation exists to modify Yamada to include the claim limitations regarding the claim limitations of the elements of claim 62. Therefore, Appellant asserts that any combination of the Yamada et al. reference, the Schultz et al. reference, and the Pluddemann reference cannot and does not establish a *prima facie* case of obviousness under 35 U.S.C. § 103 regarding the presently claimed inventions of presently amended independent claim 62 as well as the dependent claims therefrom. Accordingly, the rejection of independent claim 62 as well as dependent claim 63 should be reversed.

iv. Claim 64

Claim 64 of the presently claimed invention recites "[a] method for applying a material between a semiconductor device having a surface and a substrate having a surface, said semiconductor device mounted on said substrate, said method comprising: applying a essentially uniform liquid silane-based wetting agent layer having a total thickness of about a monolayer to at least one of said surface of said semiconductor device and said surface of said substrate; and applying a flowable underfill material between the substrate and the semiconductor device separately from said liquid silane-based wetting agent layer, such that said flowable material contacts said wetting agent layer."

Yamada in view of Schultz and Pluddemann cannot establish a *prima facie* case of obviousness under 35 U.S.C. § 103 regarding the claimed invention of independent claim 64 because Yamada, Schultz and Pluddemann do not teach or suggest all the claim limitations regarding the elements of the claimed invention. The Examiner has offered no motivation, either in Yamada, Schultz or Pluddemann or within the knowledge of one skilled in the art, to modify Yamada to include the claim limitations regarding the elements of the claimed invention. Further, the Examiner has not identified any problem to be solved that would provide a reason to modify Yamada and has made no showing of a reasonable expectation of success that Yamada could be modified to include the claim limitations of the elements of the claimed invention. Indeed, the teachings of Yamada, Schultz and Pluddemann teach away from such a combination.

The Examiner contends that it would have been an obvious matter of design choice to modify Yamada to include the thermoplastic encapsulant material of Schultz and the liquid

primer material for thermoplastics of Pluddemann. (Examiner's Answer, pages 9-11). Despite Yamada's teaching of the superiority of its thermosetting resin, the Examiner's Answer asserts, without any showing of support, that the thermoplastic material of Schultz is superior to the thermosetting underfill of Yamada. (Examiner's Answer, page 10; Yamada, col. 1, line 16 – col. 5, line 37). The Examiner further argues, without any showing of support, that because Yamada teaches that "other adhesion assistants" may be used with Yamada's *thermosetting* underfill, it would be obvious to also include the liquid primer for *thermoplastics* of Pluddemann. (Examiner's Answer, pages 10-11). However, the Answer is silent as to *why* one skilled in the art would be motivated to modify Yamada to meet the claim limitations.

The current rejection does not comply with the trilogy of recent Board decisions in which it was stated that the question of obviousness must be resolved "on the basis of underlying factual determinations including 1) the scope and content of the prior art, 2) any differences between the claimed subject matter and the prior art, and 3) the level of skill in the art." *See, e.g, Ex Parte Carolyn Ramsey Catan*, Appeal 2007-0820 at 9 (Board of Patent Appeals and Interferences, July 3, 2007); *Ex Parte Mary Smith*, Appeal 2007-1925 at 12 (Board of Patent Appeals and Interferences, June 25, 2007); *Ex Parte Marek Z. Kubin et al.*, Appeal 2007-0819 (Board of Patent Appeals and Interferenees, May 31, 2007). This analysis is missing from the current rejection.

The Examiner has not determined "the scope and content of the prior art," but rather has merely broadly referenced large sections of Yamada while restating the independent claims of the presently claimed invention. (Examiner's Answer, pages 5-8). *See Ex Parte Mary Smith,* 2007-1925, page 14 (*citing In re Kahn,* 441 F.3d 977, 988, 78 USPQ2d 1329, 1336 (Fed. Cir. 2006)("[R]ejections on obviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusions of obviousness.")

The Examiner does not specifically identify *where* Yamada teaches or suggests "applying a essentially uniform liquid silane-based wetting agent layer having a total thickness of about a monolayer to at least one of said surface of said semiconductor device and said surface of said substrate" or "applying a flowable underfill material between the substrate and the semiconductor

device separately from said liquid silane-based wetting agent layer, such that said flowable material contacts said wetting agent layer" as recited in claim 64.

Appellant asserts that as set forth in MPEP § 2111 pending claims must be given their broadest reasonable interpretation consistent with the specification. Appellant asserts that the broadest reasonable interpretation of the claims must also be consistent with the interpretation that those skilled in the art would reach. Appellant asserts that during examination the USPTO must give claims their broadest reasonable interpretation in light of the specification which means that the words of the claims must be given their plain meaning unless the plain meaning is inconsistent with the specification. Appellant asserts that the ordinary and customary meaning of a term may be evidenced by a variety of sources, including the words of the claims themselves, the remainder of the specification, the prosecution history, and extrinsic evidence concerning relevant scientific principles, the meaning of technical terms, and the state of the art. Appellant asserts that if extrinsic reference sources, such as dictionaries, evidence more than one definition for the term, the intrinsic record must be consulted to identify which of the different possible definitions is most consistent with applicant's use of the terms.

In contrast to the elements of the presently claimed invention of independent claim 64 the Yamada et al. reference teaches or suggests the use of a polymer wax layer. Appellant asserts that the Yamada et al. wax layer is not an "essentially uniform liquid silane-based wetting agent layer" as recited in claim 64 and does not describe applying a wetting agent or essentially uniform liquid silane-based wetting agent layer to at least one of said surface of said semiconductor device and said surface of said substrate whatsoever. Yamada et al. in column 18, lines 48-57 states that "[a]ccording to the eighth embodiment, since a polymer film excellent in wettability to an encapsulation resin is coated in advance on either one of a semiconductor chip and a wiring circuit board, it is possible to employ a resin of high viscosity without requiring a longer period of time for accomplishing the encapsulating, i.e. realizing a high speed encapsulating. The employment of a resin having an increased viscosity through the use of a large amount of filler may be useful in enhancing the reliability of the resultant semiconductor device." Yamada et al. in column 54, lines 30-41, states that "[o]n the passivation film 223 of the semiconductor chip is formed a polymer film 208 which is excellent in wettability with the

encapsulation resin, such as a hydrocarbon wax, a fatty acid type wax, a fatty amide type wax or an ester type wax. For example, an ester type was such as carnauba wax or montain wax is perfereable in view of their excellent moisture resistance. Other examples useful in this Example are a long chain carboxylic acid or a metal salt thereof, such as steric acid, palmitic acid, zinc stearate and calcium stearate: and a low molecular polyethylene wax. These polymers may be employed singly or in combination thereof. Other adhesion assistants may also be coated on the passivation film 223 (rather than the polymer wax film 208 or polymer layer 208) . . . ." These other adhesion assistants are not used in place of either the first encapsulation resin 204 or the second encapsulation resin 205 or are not applied thereto after the resins 204 and 205 are applied to the semiconductor chip 201 and substrate 202 respectively. The polymer film 208 contacts either the semiconductor chip 201 and the first encapsulation resin 204 or the substrate 202 and the second encapsulation resin 205 but does not contact encapsulation resin 206 located between first encapsulation resin 204 on the semiconductor chip 201 or the second encapsulation resin 205 on the substrate 202. Neither the polymer film 208 nor any adhesion assistant used in place of polymer film 208 contacts the flowable underfill resin 206 which contacts first encapsulation resin 204 and second encapsulation resin 205.

If the Examiner is applying Yamada et al. in the same manner as with claim 58, the Examiner equates the claim language setting forth the element of the claimed invention calling for "applying an essentially uniform liquid silane-based wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate" to the coupling agent in the second encapsulation resin 205 set forth in Yamada, col. 56, lines 45-59 wherein ". . . a 10μm-thick (sic) a second epoxy encapsulation resin comprising 350 parts by weight of cresol novolak type epoxy resin (ECON- 195XL: Sumitomo Kagaku Co.) containing a different content of filler from that in the first encapsulation resin, 54 parts by weight of phenol resin as a curing agent, 100 parts by weight of fused silica as a filler, 0.5 part by weight of benzylmethyl amine as a catalyst, 3 parts be weight of silane coupling agent, these components being pulverized, mixed and molten together, was coated on the surface of the wiring circuit board 202 covered in advance with a solder resist 222, thereby forming a second encapsulation resin layer 205. The coating method of this second encapsulation resin may be arbitrary selected." Yamada

et al. teaches or suggests that when a polymer wax layer 208 or polymer film 208, excellent in wettability to an encapsulation resin, is coated in advance on either one of a semiconductor chip 201 and a wiring circuit board 202, it is possible to employ a resin of high viscosity without requiring a longer period of time for accomplishing the encapsulating, i.e. realizing a high speed encapsulating. Then employment of a resin, such as second resin 205, having an increased viscosity through the use of a large amount of filler may be useful in enhancing the reliability of the resultant semiconductor device. The polymer 208 is applied to enhance the first encapsulation resin 204 or second encapsulation resin 205 contacting the semiconductor chip 201 and substrate 202. The first encapsulation resin 204 and second encapsulation resin 205 subsequently contact with the flowable underfill encapsulation resin 206 located between the semiconductor chip 201 and the substrate 202. The polymer film 208 is not in contact with the flowable underfill encapsulation resin 206 at any time. Nowhere in Yamada et al is there any teaching or suggestion of using the polymer wax film 208 to be applied to the first encapsulation resin 204 and second encapsulation resin 205 after the resins 204 and 205 have been applied to the semiconductor chip 201 and substrate 202. Nowhere in any teaching or suggestion of a second encapsulation resin layer 205 is there any teaching or suggestion of the element of the claimed invention of claim 10 calling for "applying an essentially uniform liquid silane-based wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate". Appellant asserts that there is no broadest reasonable interpretation to one of ordinary skill in the art for the element of the claimed invention calling for "applying a uniform liquid silane-based wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate" to be taught or suggested by Yamada et al. as the second encapsulation resin layer 205 comprising 350 parts by weight of cresol novolak type epoxy resin (ECON- 195XL; Sumitomo Kagaku Co.) containing a different content of filler from that in the first encapsulation resin, 54 parts by weight of phenol resin as a curing agent, 100 parts by weight of fused silica as a filler, 0.5 part by weight of benzylmethyl amine as a catalyst, 3 parts be weight of silane coupling agent, these components being pulverized, mixed and molten together, coated on the surface of the wiring circuit board 202 covered in advance with a solder resist 222, thereby forming a second encapsulation resin layer

205. Appellant asserts that nowhere in Yamada et al. is there any such teaching or suggestion of the element of the claimed invention calling for "applying an essentially uniform liquid silane-based wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate" or "a liquid wetting agent". Appellant asserts that there has been no showing that anyone of ordinary skill in the art would have as the broadest reasonable interpretation of such an element of the claimed invention and the language in the claim the for any teaching or suggestion regarding the resin 205 set forth in Yamada et al. in col. 56, lines 45-59 and relied on by the Examiner in the Final Rejection. Appellant asserts that the encapsulation resin layer 205 is not a uniform liquid silane-based wetting agent layer or a liquid wetting agent layer as set forth in the element of the claimed invention of claim 62 calling for "applying a uniform liquid silane-based wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate". Yamada et al. only teaches or suggests a polymer wax layer 208 or polymer film 208 or other adhesion assistants which may be used in its place as having wettability for the application of first encapsulation resin 204 and second encapsulation resin 205 to the semiconductor chip 201 and the substrate 202.

Further, in the Final Rejection and Examiner's Answer it is proposed that "it would have been obvious to combine this disclosure of Pluddemann with the disclosure of the combination of Yamada and Schultz because it would provide the 'other adhesion assistants' of Yamada having improved wetting to the thermoplastic underfill material of Yamada and Schultz". However, the "other adhesion assistants" in Yamada et al. refers to the polymer film 208 located between either the semiconductor chip 201 and the first encapsulation resin 204 or the polymer film 208 located between the second encapsulation reason 205 and the substrate. There is no teaching or suggestion in Yamada et al. that "other adhesion assistants" may be used for the second encapsulation resin 205. Additionally, if the Pluddemann wetting agent layer is used in place of second encapsulation resin 205 in Yamada et al., since the Pluddemann wetting agent layer is not an encapsulation resin, the teachings and suggestions of Yamada et al. regarding the Yamada et al. invention have been destroyed. If the polymer wax layer 208 or polymer layer 208 of Yamada et al. is replaced by the Pluddemann wetting agent layer, such a layer is not in contact with the flowable underfill material which is required by claim 64.

Appellant asserts that in either event where the Pluddemann wetting agent layer is either substituted for the polmer wax layer 208 or polymer layer 208 of Yamada et al. or replaces the second encapsulation resin 205 of Yamada et al., any combination of Yamada et al. and Schultz and Pluddemann cannot establish a *prima facie* case of obviousness under 35 U.S.C. § 103 because either the claim limitations of claim 64 are not taught or suggested or the invention of Yamada et al. is destroyed for intended use.

Appellant further asserts that if it is intended to additionally use the Pluddemann wetting agent on the other side of second encapsulation layer 205 of Yamada et al. with the polymer wax layer 208 or the polymer layer 208 on the substrate 202 side, Yamada et al. does not teach or suggest any such arrangement and it is a total hindsight reconstruction based solely upon Appellant's disclosure of the invention of claim 64 to do so.

Appellant assert that as set forth in the ELECTRONIC PACKAGING, MICROELECTRONICS, AND INTERCONNECTION DICTIONARY, as published by McGraw-Hill, Inc., copyright 1993 by McGraw-Hill, Inc. one of ordinary skill in the art knows and understands that a coupling agent is "a chemical material that can react with both the reinforcement and the resin matrix of a composite or laminate to promote a stronger bond at the interface. The agent may be applied to the reinforcement or added to the resin, or both." (See also Silanes.) Appellant asserts that one of ordinary skill in the art knows that silanes are "silicon-based chemical compounds used to treat inorganic materials such as glass fibers or mineral fillers, thereby improving the adhesion between these materials and organic resins. Silanes may be applied to the inorganic material, added to the organic material, or both. One important use is for adhesion-promoting coupling agents between glass fibers and organic resins in the manufacture of laminates for printed wiring boards." (See also Coupling Agent.) Appellant asserts that one of ordinary skill in the art knows that wetting is "(1) the ability to adhere to a surface immediately upon contact. (2) In soldering, the ability of molten solder to spread over a metal surface after the application of a flux and the proper amount of heat." Appellant asserts that one of ordinary skill in the art knows that wettability is "the degree to which surface wetting occurs. Contact can be made between the solder and metal to be soldered." (See also Wetting.)

Appellant asserts that one of ordinary skill in the art knows that the 3 parts of silane of the 453.5 total parts of the material of the second encapsulation resin layer 205 of Yamada et al. is present as a coupling agent so that the fused silica (mineral filler) and the resin can react to promote a stronger bond at the interface thereof when the resin is curing. Appellant asserts that the second encapsulation resin layer 205 of Yamada et al. is not the element of the claimed invention of claim 64 calling for "applying a uniform liquid silane-based wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate" or "a liquid wetting agent". Appellant asserts that the plain meaning of the element of the claimed invention calling for "applying a uniform liquid silane-based wetting agent layer to one of said active surface of said semiconductor device and said upper surface of said substrate" or "a liquid wetting agent" clearly distinguishes such from any reasonable broad interpretation of the second encapsulation layer 205 of Yamada et al. by of one of ordinary skill in the art.

The Examiner acknowledges that neither Yamada nor Schultz teaches or suggests "applying a essentially uniform liquid silane-based wetting agent layer . . . to at least one of said surface of said semiconductor device and said surface of said substrate" or "applying a flowable underfill material between the substrate and the semiconductor device separately from said liquid silane-based wetting agent layer, such that said flowable material contacts said wetting agent layer" as recited in claim 64. (Examiner's Answer, page 10). Pluddemann cannot cure the deficiencies of Yamada and Schultz. Further, the Examiner acknowledges that none of the references teach or suggest "applying a essentially uniform liquid silane-based wetting agent layer having a total thickness of about a monolayer to at least one of said surface of said semiconductor device and said surface of said substrate." *(Id.)*

The Yamada reference clearly uses a thermosetting material as an underfill material because the Yamada teaches or suggests thermosetting resin. (Yamada, col. 56, lines, 23-61). The Examiner has not identified any problem to be solved in Yamada that would lead one of skill in the art to modify Yamada to include the thermoplastic material of Schultz (which is not a claim limitation of claim 64) and the liquid primer for thermoplastics of Pluddemann. The inclusion of the Schultz reference in the rejection suggests that the liquid primer for

thermoplastics of Pluddemann would not be compatible with the underfill of Yamada. Thus, Pluddemann and Yamada teach away from a direct combination.

The Schultz reference solely teaches or suggests the use of a thermoplastic material for an encapsulant and thus no motivation exists to substitute the Schultz encapsulant for the Yamada underfill material. Further, Yamada discloses the problems with prior art underfills and the superiority of the Yamada thermosetting resin. (Yamada, col. 1, line 16 – col. 5, line 37; Yamada col. 5, line 62- col. 10, line 13; col. 13, line 58 – col. 17, line 22). Thus, the Yamada reference teaches away from the Schultz encapsulant material. The Examiner has simply failed to identify any motivation to modify the Yamada structure to include a liquid primer for thermoplastics of Pluddemann. The Examiner's statements are merely conclusions based on a hindsight reconstruction of the claimed invention based on Appellant's own disclosure.

Yamada cannot teach or suggest the use of a thermoplastic underfill and no motivation exists to modify Yamada to include a thermoplastic underfill because a thermoplastic underfill would soften with an increase of temperature when the IC chip is being operated so that the thermoplastic underfill would be unable to compensate for any thermal mismatch between IC chip and the IC carrier thereby making the Yamada et al. invention inoperable due to the thermoplastic material loosing its strength as it is heated thereby allowing the IC chip to separate from the substrate as the bump electrodes 203 fail in shear due to the thermo-plastic material carrying no load. Additionally, thermoplastic materials have too high viscosity to be used as underfill materials as they are unable to effectively fill the small space between an IC chip mounted on an IC chip carrier using solder balls where the small space is 125 microns or less in height. Indeed, Yamada discloses, at length, drawbacks to underfill materials other than those thermosetting materials disclosed therein. (Yamada, col. 1, line 16- col. 5, line 35). Thus, no motivation exists to modify Yamada to include the thermoplastic encapsulant of Schultz.

Both Schultz and Pluddemann teach away from any combination with and modification of Yamada because no likelihood of success exists that a thermoplastic encapsulant would be a suitable substitute for a thermosetting underfill. The substitution of a thermoplastic resin of Schultz for a thermosetting resin of Yamada destroys the Yamada invention as it would fail since in operation, the thermoplastic resin of Schultz would allow the device to separate and the bump

electrodes 203 to fail in shear due to the thermoplastic resin carrying no load. Further, Appellant asserts that the substitution of a liquid primer composition from Pluddemann for a resin of Yamada cannot be the substitution of an equivalent.

The Examiner states that "there is no requirement that the cited prior art contain any suggestion for any combination thereof." (Examiner's Answer, page 29). However, to make a prima facie case of obviousness, the Examiner must identify "a reason that would have prompted a person of ordinary skill in the relevant field to combine the [prior art] elements" in the manner claimed. *KSR Int'l Co.* 127 S. Ct. 1727; *Ex Parte Kubin,* Appeal 2007-0819, page 9. The Examiner has not met his burden in this case. The reason that would have prompted the combination and the reasonable expectation of success must be found in the prior art, common knowledge, or the nature of the problem itself, and not based on the Applicant's disclosure. *DyStar Textilfarben*, 464 F.3d at 1367. The Office Action is silent as to *why* one skilled in the art would be motivated to modify Yamada to meet the claim limitations or what commonality may be found in the Yamada, Schultz and Pluddemann references.

The sole teaching or suggestion for the use of a liquid silane-based material layer to one of a portion of said active surface of said semiconductor device and a portion of said upper surface of said substrate for use with an underfill material is solely the Appellant's disclosure because the cited prior art teaches away from any combination thereof, because if the prior art is combined as suggested in the rejection, the combination clearly destroys the operability of the primary reference and because the cited prior art does not contain any suggestion for any combination thereof.

Yamada et al., Schultz et al., and Pluddemann fails to teach or suggest the claim limitations of the elements of claim 64 and no motivation exists to modify Yamada to include the claim limitations regarding the claim limitations of the elements of claim 64. Therefore, Appellant asserts that any combination of the Yamada et al. reference, the Schultz et al. reference, and the Pluddemann reference cannot and does not establish a *prima facie* case of obviousness under 35 U.S.C. § 103 regarding the presently claimed inventions of presently amended independent claim 64. Accordingly, the rejection of independent claim 64 should be reversed.

b. Claim 64 stands rejected under 35 U.S.C. §103(a) as being obvious over Yamada in view of Schultz (U.S. Patent 6,350,840) and Pluddemann (U.S. Patent 4,961,967), in further combination with Hieda (U.S. Patent 6,303,277).

The discussion of Yamada, Schultz and Pluddemann, *supra,* is incorporated herein. The Hieda reference teaches or suggests the use of a monomolecular film or a monoatomic film of an alkane thiol on a substrate to be etched.

Claim 64 of the presently claimed invention recites "[a] method for applying a material between a semiconductor device having a surface and a substrate having a surface, said semiconductor device mounted on said substrate, said method comprising: applying a essentially uniform liquid silane-based wetting agent layer having a total thickness of about a monolayer to at least one of said surface of said semiconductor device and said surface of said substrate; and applying a flowable underfill material between the substrate and the semiconductor device separately from said liquid silane-based wetting agent layer, such that said flowable material contacts said wetting agent layer."

Yamada in view of Schultz, Pluddemann and Hieda cannot establish a *prima facie* case of obviousness under 35 U.S.C. § 103 regarding the claimed invention of independent claim 64 because Yamada, Schultz, Pluddemann and Hieda do not teach or suggest all the claim limitations regarding the elements of the claimed invention. The Examiner has offered no motivation, either in Yamada, Schultz, Pluddemann or Hieda or within the knowledge of one skilled in the art, to modify Yamada to include the claim limitations regarding the elements of the claimed invention. Further, the Examiner has not identified any problem to be solved that would provide a reason to modify Yamada and has made no showing of a reasonable expectation of success that Yamada could be modified to include the claim limitations of the elements of the claimed invention. Indeed, the teachings of Yamada, Schultz and Pluddemann teach away from such a combination.

The Examiner contends that it would have been an obvious matter of design choice to modify Yamada to include the thermoplastic encapsulant material of Schultz and the liquid

primer material for thermoplastics of Pluddemann. (Examiner's Answer, pages 9-11). Despite Yamada's teaching of the superiority of its thermosetting resin, the Examiner's Answer asserts, without any showing of support, that the thermoplastic material of Schultz is superior to the thermosetting underfill of Yamada. (Examiner's Answer, page 10; Yamada, col. 1, line 16 – col. 5, line 37). The Examiner further argues, without any showing of support, that because Yamada teaches that "other adhesion assistants" may be used with Yamada's *thermosetting* underfill, it would be obvious to also include the liquid primer for *thermoplastics* of Pluddemann. (Examiner's Answer, pages 10-11). However, the Answer is silent as to *why* one skilled in the art would be motivated to modify Yamada to meet the claim limitations. Similarly, the Examiner's Answer asserts, without foundation, that because Hieda discloses a material having a thickness of a monolayer, it would have been obvious to include a monolayer in the Yamada reference.

The current rejection does not comply with the trilogy of recent Board decisions in which it was stated that the question of obviousness must be resolved "on the basis of underlying factual determinations including 1) the scope and content of the prior art, 2) any differences between the claimed subject matter and the prior art, and 3) the level of skill in the art." *See, e.g, Ex Parte Carolyn Ramsey Catan,* Appeal 2007-0820 at 9 (Board of Patent Appeals and Interferences, July 3, 2007); *Ex Parte Mary Smith*, Appeal 2007-1925 at 12 (Board of Patent Appeals and Interferences, June 25, 2007); *Ex Parte Marek Z. Kubin et al.*, Appeal 2007-0819 (Board of Patent Appeals and Interferences, May 31, 2007). This analysis is missing from the current rejection.

The Examiner has not determined "the scope and content of the prior art," but rather has merely broadly referenced large sections of Yamada while restating the independent claims of the presently claimed invention. (Examiner's Answer, pages 5-8). *See Ex Parte Mary Smith,* 2007-1925, page 14 (*citing In re Kahn,* 441 F.3d 977, 988, 78 USPQ2d 1329, 1336 (Fed. Cir. 2006)("[R]ejections on obviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusions of obviousness.")

The Examiner does not specifically identify *where* Yamada teaches or suggests "applying a essentially uniform liquid silane-based wetting agent layer having a total thickness of about a monolayer to at least one of said surface of said semiconductor device and said surface of said substrate" or "applying a flowable underfill material between the substrate and the semiconductor device separately from said liquid silane-based wetting agent layer, such that said flowable material contacts said wetting agent layer" as recited in claim 64.

Appellant asserts that as set forth in MPEP § 2111 pending claims must be given their broadest reasonable interpretation consistent with the specification. Appellant asserts that the broadest reasonable interpretation of the claims must also be consistent with the interpretation that those skilled in the art would reach. Appellant asserts that during examination the USPTO must give claims their broadest reasonable interpretation in light of the specification which means that the words of the claims must be given their plain meaning unless the plain meaning is inconsistent with the specification. Appellant asserts that the ordinary and customary meaning of a term may be evidenced by a variety of sources, including the words of the claims themselves, the remainder of the specification, the prosecution history, and extrinsic evidence concerning relevant scientific principles, the meaning of technical terms, and the state of the art. Appellant asserts that if extrinsic reference sources, such as dictionaries, evidence more than one definition for the term, the intrinsic record must be consulted to identify which of the different possible definitions is most consistent with applicant's use of the terms.

In contrast to the elements of the presently claimed invention of independent claim 64 the Yamada et al. reference teaches or suggests the use of a polymer wax layer. Appellant asserts that the Yamada et al. wax layer is not a "essentially uniform liquid silane-based wetting agent layer having a total thickness of about a monolayer" as recited in claim 64 and does not describe applying a wetting agent or essentially uniform liquid silane-based wetting agent layer to at least one of said surface of said semiconductor device and said surface of said substrate whatsoever. Yamada et al. in column 18, lines 48-57 states that "[a]ccording to the eighth embodiment, since a polymer film excellent in wettability to an encapsulation resin is coated in advance on either one of a semiconductor chip and a wiring circuit board, it is possible to employ a resin of high viscosity without requiring a longer period of time for accomplishing the encapsulating, i.e.

realizing a high speed encapsulating. The employment of a resin having an increased viscosity through the use of a large amount of filler may be useful in enhancing the reliability of the resultant semiconductor device." Yamada et al. in column 54, lines 30-41, states that "[o]n the passivation film 223 of the semiconductor chip is formed a polymer film 208 which is excellent in wettability with the encapsulation resin, such as a hydrocarbon wax, a fatty acid type wax, a fatty amide type wax or an ester type wax. For example, an ester type was such as carnauba wax or montain wax is perfereable in view of their excellent moisture resistance. Other examples useful in this Example are a long chain carboxylic acid or a metal salt thereof, such as steric acid, palmitic acid, zinc stearate and calcium stearate; and a low molecular polyethylene wax. These polymers may be employed singly or in combination thereof. Other adhesion assistants may also be coated on the passivation film 223 (rather than the polymer wax film 208 or polymer layer 208) . . . ." These other adhesion assistants are not used in place of either the first encapsulation resin 204 or the second encapsulation resin 205 or are not applied thereto after the resins 204 and 205 are applied to the semiconductor chip 201 and substrate 202 respectively. The polymer film 208 contacts either the semiconductor chip 201 and the first encapsulation resin 204 or the substrate 202 and the second encapsulation resin 205 but does not contact encapsulation resin 206 located between first encapsulation resin 204 on the semiconductor chip 201 or the second encapsulation resin 205 on the substrate 202. Neither the polymer film 208 nor any adhesion assistant used in place of polymer film 208 contacts the flowable underfill resin 206 which contacts first encapsulation resin 204 and second encapsulation resin 205.

If the Examiner is applying Yamada et al. in the same manner as with claim 58, the Examiner equates the claim language setting forth the element of the claimed invention calling for "applying a essentially uniform liquid silane-based wetting agent layer having a total thickness of about a monolayer to one of said active surface of said semiconductor device and said upper surface of said substrate" to the coupling agent in the second encapsulation resin 205 set forth in Yamada, col. 56, lines 45-59 wherein ". . . a 10μm-thick (sic) a second epoxy encapsulation resin comprising 350 parts by weight of cresol novolak type epoxy resin (ECON- 195XL; Sumitomo Kagaku Co.) containing a different content of filler from that in the first encapsulation resin, 54 parts by weight of phenol resin as a curing agent, 100 parts by weight of fused silica as a

filler, 0.5 part by weight of benzylmethyl amine as a catalyst, 3 parts be weight of silane coupling agent, these components being pulverized, mixed and molten together, was coated on the surface of the wiring circuit board 202 covered in advance with a solder resist 222, thereby forming a second encapsulation resin layer 205. The coating method of this second encapsulation resin may be arbitrary selected." Yamada et al. teaches or suggests that when a polymer wax layer 208 or polymer film 208, excellent in wettability to an encapsulation resin, is coated in advance on either one of a semiconductor chip 201 and a wiring circuit board 202, it is possible to employ a resin of high viscosity without requiring a longer period of time for accomplishing the encapsulating, i.e. realizing a high speed encapsulating. Then employment of a resin, such as second resin 205, having an increased viscosity through the use of a large amount of filler may be useful in enhancing the reliability of the resultant semiconductor device. The polymer 208 is applied to enhance the first encapsulation resin 204 or second encapsulation resin 205 contacting the semiconductor chip 201 and substrate 202. The first encapsulation resin 204 and second encapsulation resin 205 subsequently contact with the flowable underfill encapsulation resin 206 located between the semiconductor chip 201 and the substrate 202. The polymer film 208 is not in contact with the flowable underfill encapsulation resin 206 at any time. Nowhere in Yamada et al is there any teaching or suggestion of using the polymer wax film 208 to be applied to the first encapsulation resin 204 and second encapsulation resin 205 after the resins 204 and 205 have been applied to the semiconductor chip 201 and substrate 202. Nowhere in any teaching or suggestion of a second encapsulation resin layer 205 is there any teaching or suggestion of the element of the claimed invention of claim 10 calling for "applying a essentially uniform liquid silane-based wetting agent layer having a total thickness of about a monolayer to one of said active surface of said semiconductor device and said upper surface of said substrate". Appellant asserts that there is no broadest reasonable interpretation to one of ordinary skill in the art for the element of the claimed invention calling for "applying a essentially uniform liquid silane-based wetting agent layer having a total thickness of about a monolayer to one of said active surface of said semiconductor device and said upper surface of said substrate" to be taught or suggested by Yamada et al. as the second encapsulation resin layer 205 comprising 350 parts by weight of cresol novolak type epoxy resin (ECON- 195XL; Sumitomo Kagaku Co.) containing a different

content of filler from that in the first encapsulation resin, 54 parts by weight of phenol resin as a curing agent, 100 parts by weight of fused silica as a filler, 0.5 part by weight of benzylmethyl amine as a catalyst, 3 parts be weight of silane coupling agent, these components being pulverized, mixed and molten together, coated on the surface of the wiring circuit board 202 covered in advance with a solder resist 222, thereby forming a second encapsulation resin layer 205. Appellant asserts that nowhere in Yamada et al. is there any such teaching or suggestion of the element of the claimed invention calling for "applying a essentially uniform liquid silane-based wetting agent layer having a total thickness of about a monolayer to one of said active surface of said semiconductor device and said upper surface of said substrate" or "a liquid wetting agent". Appellant asserts that there has been no showing that anyone of ordinary skill in the art would have as the broadest reasonable interpretation of such an element of the claimed invention and the language in the claim the for any teaching or suggestion regarding the resin 205 set forth in Yamada et al. in col. 56, lines 45-59 and relied on by the Examiner in the Final Rejection. Appellant asserts that the encapsulation resin layer 205 is not a uniform liquid silane-based wetting agent layer or a liquid wetting agent layer as set forth in the element of the claimed invention of claim 62 calling for "applying a essentially uniform liquid silane-based wetting agent layer having a total thickness of about a monolayer to one of said active surface of said semiconductor device and said upper surface of said substrate". Yamada et al. only teaches or suggests a polymer wax layer 208 or polymer film 208 or other adhesion assistants which may be used in its place as having wettability for the application of first encapsulation resin 204 and second encapsulation resin 205 to the semiconductor chip 201 and the substrate 202.

Further, in the Final Rejection and Examiner's Answer it is proposed that "it would have been obvious to combine this disclosure of Pluddemann with the disclosure of the combination of Yamada and Schultz because it would provide the 'other adhesion assistants' of Yamada having improved wetting to the thermoplastic underfill material of Yamada and Schultz". However, the "other adhesion assistants" in Yamada et al. refers to the polymer film 208 located between either the semiconductor chip 201 and the first encapsulation resin 204 or the polymer film 208 located between the second encapsulation reason 205 and the substrate. There is no teaching or suggestion in Yamada et al. that "other adhesion assistants" may be used for the

second encapsulation resin 205. Additionally, if the Pluddemann wetting agent layer is used in place of second encapsulation resin 205 in Yamada et al., since the Pluddemann wetting agent layer is not an encapsulation resin, the teachings and suggestions of Yamada et al. regarding the Yamada et al. invention have been destroyed. If the polymer wax layer 208 or polymer layer 208 of Yamada et al. is replaced by the Pluddemann wetting agent layer, such a layer is not in contact with the flowable underfill material which is required by claim 64.

Appellant asserts that in either event where the Pluddemann wetting agent layer is either substituted for the polmer wax layer 208 or polymer layer 208 of Yamada et al. or replaces the second encapsulation resin 205 of Yamada et al., any combination of Yamada et al. and Schultz and Pluddemann cannot establish a *prima facie* case of obviousness under 35 U.S.C. § 103 because either the claim limitations of claim 64 are not taught or suggested or the invention of Yamada et al. is destroyed for intended use.

Appellant further asserts that if it is intended to additionally use the Pluddemann wetting agent on the other side of second encapsulation layer 205 of Yamada et al. with the polymer wax layer 208 or the polymer layer 208 on the substrate 202 side, Yamada et al. does not teach or suggest any such arrangement and it is a total hindsight reconstruction based solely upon Appellant's disclosure of the invention of claim 64 to do so.

Appellant assert that as set forth in the ELECTRONIC PACKAGING, MICROELECTRONICS, AND INTERCONNECTION DICTIONARY, as published by McGraw-Hill, Inc., copyright 1993 by McGraw-Hill, Inc. one of ordinary skill in the art knows and understands that a coupling agent is "a chemical material that can react with both the reinforcement and the resin matrix of a composite or laminate to promote a stronger bond at the interface. The agent may be applied to the reinforcement or added to the resin, or both." (See also Silanes.) Appellant asserts that one of ordinary skill in the art knows that silanes are "silicon-based chemical compounds used to treat inorganic materials such as glass fibers or mineral fillers, thereby improving the adhesion between these materials and organic resins. Silanes may be applied to the inorganic material, added to the organic material, or both. One important use is for adhesion-promoting coupling agents between glass fibers and organic resins in the manufacture of laminates for printed wiring boards." (See also Coupling Agent.)

Appellant asserts that one of ordinary skill in the art knows that wetting is "(1) the ability to adhere to a surface immediately upon contact. (2) In soldering, the ability of molten solder to spread over a metal surface after the application of a flux and the proper amount of heat." Appellant asserts that one of ordinary skill in the art knows that wettability is "the degree to which surface wetting occurs. Contact can be made between the solder and metal to be soldered." (See also Wetting.)

Appellant asserts that one of ordinary skill in the art knows that the 3 parts of silane of the 453.5 total parts of the material of the second encapsulation resin layer 205 of Yamada et al. is present as a coupling agent so that the fused silica (mineral filler) and the resin can react to promote a stronger bond at the interface thereof when the resin is curing. Appellant asserts that the second encapsulation resin layer 205 of Yamada et al. is not the element of the claimed invention of claim 64 calling for "applying a essentially uniform liquid silane-based wetting agent layer having a total thickness of about a monolayer to one of said active surface of said semiconductor device and said upper surface of said substrate" or "a liquid wetting agent". Appellant asserts that the plain meaning of the element of the claimed invention calling for "applying a essentially uniform liquid silane-based wetting agent layer having a total thickness of about a monolayer to one of said active surface of said semiconductor device and said upper surface of said substrate" or "a liquid wetting agent" clearly distinguishes such from any reasonable broad interpretation of the second encapsulation layer 205 of Yamada et al. by of one of ordinary skill in the art.

The Examiner acknowledges that neither Yamada nor Schultz teaches or suggests "applying a essentially uniform liquid silane-based wetting agent layer . . . to at least one of said surface of said semiconductor device and said surface of said substrate" or "applying a flowable underfill material between the substrate and the semiconductor device separately from said liquid silane-based wetting agent layer, such that said flowable material contacts said wetting agent layer" as recited in claim 64. (Examiner's Answer, page 10). Pluddemann cannot cure the deficiencies of Yamada and Schultz.

The Yamada reference clearly uses a thermosetting material as an underfill material because the Yamada teaches or suggests thermosetting resin. (Yamada, col. 56, lines, 23-61).

The Examiner has not identified any problem to be solved in Yamada that would lead one of skill in the art to modify Yamada to include the thermoplastic material of Schultz (which is not a claim limitation of claim 64) and the liquid primer for thermoplastics of Pluddemann. The inclusion of the Schultz reference in the rejection suggests that the liquid primer for thermoplastics of Pluddemann would not be compatible with the underfill of Yamada. Thus, Pluddemann and Yamada teach away from a direct combination.

The Schultz reference solely teaches or suggests the use of a thermoplastic material for an encapsulant and thus no motivation exists to substitute the Schultz encapsulant for the Yamada underfill material. Further, Yamada discloses the problems with prior art underfills and the superiority of the Yamada thermosetting resin. (Yamada, col. 1, line 16 – col. 5, line 37; Yamada col. 5, line 62- col. 10, line 13; col. 13, line 58 – col. 17, line 22). Thus, the Yamada reference teaches away from the Schultz encapsulant material. The Examiner has also failed to identify any motivation to modify the Yamada structure to include a liquid primer for thermoplastics of Pluddemann or the thickness of a particular layer in Hieda The Examiner's statements are merely conclusions based on a hindsight reconstruction of the claimed invention based on Appellant's own disclosure.

Yamada cannot teach or suggest the use of a thermoplastic underfill and no motivation exists to modify Yamada to include a thermoplastic underfill because a thermoplastic underfill would soften with an increase of temperature when the IC chip is being operated so that the thermoplastic underfill would be unable to compensate for any thermal mismatch between IC chip and the IC carrier thereby making the Yamada et al. invention inoperable due to the thermoplastic material loosing its strength as it is heated thereby allowing the IC chip to separate from the substrate as the bump electrodes 203 fail in shear due to the thermo-plastic material carrying no load. Additionally, thermoplastic materials have too high viscosity to be used as underfill materials as they are unable to effectively fill the small space between an IC chip mounted on an IC chip carrier using solder balls where the small space is 125 microns or less in height. Indeed, Yamada discloses, at length, drawbacks to underfill materials other than those thermosetting materials disclosed therein. (Yamada, col. 1, line 16- col. 5, line 35). Thus, no motivation exists to modify Yamada to include the thermoplastic encapsulant of Schultz.

Both Schultz and Pluddemann teach away from any combination with and modification of Yamada because no likelihood of success exists that a thermoplastic encapsulant would be a suitable substitute for a thermosetting underfill. The substitution of a thermoplastic resin of Schultz for a thermosetting resin of Yamada destroys the Yamada invention as it would fail since in operation, the thermoplastic resin of Schultz would allow the device to separate and the bump electrodes 203 to fail in shear due to the thermoplastic resin carrying no load. Further, Appellant asserts that the substitution of a liquid primer composition from Pluddemann for a resin of Yamada cannot be the substitution of an equivalent.

The Examiner relies upon Hieda to teach "applying an essentially uniform liquid silane-based wetting agent layer having a total thickness of about a monolayer to at least one of said surface of said semiconductor device and said surface of said substrate." The alleged monolayer in Hieda is not a "uniform liquid silane-based wetting agent layer" and the Examiner has not explained why Heida would motivate one to modify the liquid primer of Pluddemann to have a particular thickness. Further, the Examiner fails to identify any commonality between Yamada and Hieda that would motivate one to combine the references.

The Examiner states that "there is no requirement that the cited prior art contain any suggestion for any combination thereof." (Examiner's Answer, page 29). However, to make a prima facie case of obviousness, the Examiner must identify "a reason that would have prompted a person of ordinary skill in the relevant field to combine the [prior art] elements" in the manner claimed. *KSR Int'l Co.* 127 S. Ct. 1727; *Ex Parte Kubin,* Appeal 2007-0819, page 9. The Examiner has not met his burden in this case. The reason that would have prompted the combination and the reasonable expectation of success must be found in the prior art, common knowledge, or the nature of the problem itself, and not based on the Applicant's disclosure. *DyStar Textilfarben*, 464 F.3d at 1367. The Office Action is silent as to *why* one skilled in the art would be motivated to modify Yamada to meet the claim limitations or what commonality may be found in the Yamada, Schultz, Pluddemann and Heida references.

The sole teaching or suggestion for the use of a liquid silane-based material layer to one of a portion of said active surface of said semiconductor device and a portion of said upper surface of said substrate for use with an underfill material is solely the Appellant's disclosure

because the cited prior art teaches away from any combination thereof, because if the prior art is combined as suggested in the rejection, the combination clearly destroys the operability of the primary reference and because the cited prior art does not contain any suggestion for any combination thereof.

Yamada et al., Schultz et al., Pluddemann and Hieda fails to teach or suggest the claim limitations of the elements of claim 64 and no motivation exists to modify Yamada to include the claim limitations regarding the claim limitations of the elements of claim 64. Therefore, Appellant asserts that any combination of the Yamada et al. reference, the Schultz et al. reference, the Pluddemann reference and the Hieda reference cannot and does not establish a *prima facie* case of obviousness under 35 U.S.C. § 103 regarding the presently claimed inventions of presently amended independent claim 64. Accordingly, the rejection of independent claim 64 should be reversed.

c. Claims 13, 14, 16-21 and 23-30 stand rejected under 35 U.S.C. §103(a) as being obvious over Yamada in view of Schultz (U.S. Patent 6,350840) and Pluddemann (U.S. Patent 4,961,967) and in further combination with Akram (U.S. Patent 5,766,982).

The discussion of Yamada, Schultz and Pluddemann, *supra,* is incorporated herein. Akram is cited for teaching underfill methods and fails to cure the deficiencies of Yamada, Schultz and Pluddemann. Claims 13, 14, 16-21 and 23-30 depend from independent claim 10. The Court of Appeals for the Federal Circuit has stated that "dependent claims are nonobvious under section 103 if the independent claims from which they depend are nonobvious." In re Fine, 5 USPQ2d 1596, 1600 (Fed. Cir. 1988). See also MPEP § 2143.03. Having failed to teach or suggest each and every limitation of the current application, the prior art referenced as rendering dependent claims 13, 14, 16-21 and 23-30 obvious, cannot serve as a basis for rejection. Accordingly, the rejection of claims 13, 14, 16-21 and 23-30 should be reversed.

d. Claims 31 and 32 stand rejected under 35 U.S.C. §103(a) as being obvious over Yamada in view of Schultz and Pluddemann as applied to claim 10, and in further combination with Banerji (U.S. Patent 5,203,076).

The discussion of Yamada, Schultz and Pluddemann, *supra,* is incorporated herein. Banerji is cited for teaching vacuum infiltration of underfill material and fails to cure the deficiencies of Yamada, Schultz and Pluddemann. Claims 31 and 32 depend from independent claim 10. The Court of Appeals for the Federal Circuit has stated that "dependent claims are nonobvious under section 103 if the independent claims from which they depend are nonobvious." In re Fine, 5 USPQ2d 1596, 1600 (Fed. Cir. 1988). See also MPEP § 2143.03. Having failed to teach or suggest each and every limitation of the current application, the prior art referenced as rendering dependent claims 31 and 32 obvious, cannot serve as a basis for rejection. Accordingly, the rejection of claims 31 and 32 should be reversed.

CONCLUSION

Appellant respectfully submits that claims 1-5, 7-32 and 58-64 are allowable. Appellant respectfully requests that the rejection of claims 58-61 under 35 U.S.C. §102(e) and claims 1-5, 7-32 and 62-64 under 35 U.S.C. § 103(a), be reversed.

Respectfully submitted,

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